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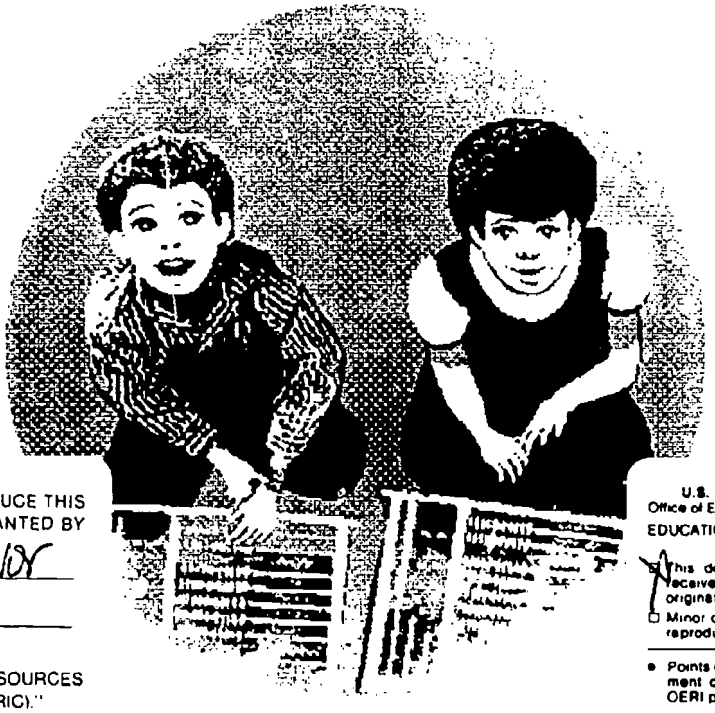
ABSTRACT

This volume is a teacher's edition in a series of books that contain open-ended exploration activities and experiments. These activities allow and encourage students to set their own goals, use their own creativity and ideas, investigate the wonders of nature, learn about the workings of real businesses, and draw conclusions from their investigations of these real-life situations. Students participate in many explorations by first making things such as a geoboard or an adding machine and then using their creations to complete the exploration or investigation. The 40 activities are grouped under the National Council of Teachers of Mathematics' (NCTM) Curriculum. Standards of: communications, spatial sense, measurement, number sense, connections, estimation, and reasoning. Some activities include: Somewhere in Time: Making a Time Capsule; Tangram Puzzles; Exploring with Puzzles; The Pendulum Swings: Investigating Time and a Pendulum; Dot Bingo: Making and Playing a Game; Mosaic: Exploring Coordinate Planes; What Is Your Surface Area? Approximating Surface Area; Experimenting with Slant: Comparing Results. Each activity contains a teacher's guide that lists: goal, student objectives, guide to the investigation, and vocabulary, along with a description of the activity that includes: an introduction, purpose, materials needed, procedures, observations, conclusions, and suggestions for further study. (MKR)

GREAT EXPLORATIONS IN MATHEMATICS

Richard W. Dyches, Ph.D Linda W. Griffith, Ph. D.
Fr. Wayland Y. Brown, M. A. Marilyn S. Neil, Ph.D.



GRADES K-4

TEACHER'S EDITION

Great Explorations in Mathematics

Grades K-4

Teacher's Edition

Richard W. Dyches, Ph. D.
National Computer Systems
Minneapolis, MN

Linda K. Griffith, Ph. D.
University of Central Arkansas
Conway, AR

Fr. Wayland Y. Brown, M. A.
Georgia Southern University
Statesboro, GA

Marilyn S. Neil, Ph. D.
West Georgia College
Carrollton, GA

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TABLE OF CONTENTS

MEASUREMENT

NUMBER SENSE

CONNECTIONS

ESTIMATION

REASONING

Introduction to Great Explorations in Mathematics Grades K-4

Great Explorations in Mathematics is just that - **Explorations!** This is one of a series of books which cover all grades from K through 12. Each of the forty activities in this volume, Grades K-4, contains open-ended explorations and experiments. These are not activities with right and wrong answers - virtually every student can experience the joy of exploration and discovery without fear of getting "the wrong answer".

Activities in this book allow and encourage students to set their own goals, to use their own creativity and ideas, to investigate the wonders of nature, to learn about the workings of real businesses, and to draw conclusions from their investigations of these real life situations. Students participate in many explorations by first making things such as a geoboard or an adding machine and then using their creations to complete the exploration or investigation.

You are involved in the investigations in several capacities: to provide the basic materials and a supportive classroom where students can investigate freely these fascinating concepts, and because of the age and experience of the students involved, to guide them step-by-step through the procedures. In most cases, you are needed to monitor students. However, students in the upper grades may be able to complete many of the explorations independently after receiving some guidance. Some explorations are to be completed in one class period, while others require several periods. Some cannot be done in school or during school hours.

The discussions you lead or moderate after each exploration provide excellent opportunities to evaluate the effectiveness of each project as well as help your class develop a great spirit of cooperative achievement. There is no intent that a formal evaluation be made in the sense that a student would be assigned a letter or numerical grade.

An examination of the Table of Contents reflects the focus of the *Curriculum and Evaluation Standards for School Mathematics* (1989) of the National Council of Teachers of Mathematics: Each "chapter" title - Communications, Spatial Sense, Measurement, Number Sense, Connections, Estimation, and Reasoning - is the main focus of one of the K-8 Standards.

How to Use the Book

For each of the forty explorations in *Great Explorations in Mathematics K-4*, there is a Teachers' Guide, two or more Student Activity pages, and, almost always, a Response Sheet.

Teachers' Guides include statements of overall goals of the exploration, student objectives, necessary vocabulary, and suggestions for ways to introduce the exploration. You will also find suggestions about implementing the exploration by having the students work alone, in pairs, or in small groups, and there are some suggestions for further study. In addition, a list of materials needed for the exploration is included. For the most part these materials are readily and cheaply available. You can, of course, make substitutions.

Student activity pages include a short introduction which is intended to capture the students' attention. The purposes of the activity may be stated in the form of questions and are restatements of the student objectives from the Teachers' Guide. Materials are listed before the Procedures Section, where the students will find step-by-step procedures for carrying out the exploration. When they have completed the procedures and recorded results on the Response Sheet(s), the students are asked questions which allow them to describe their observations. Then they record any generalizations they reach or conclusions they draw. Finally, students will be offered one or more suggestions for further study which they may pursue. These activities either extend and reinforce what students have experienced in the exploration or ask them to create their own exploration, or experience the concepts they have learned in other content areas.

About the Authors

Richard W. Dyches is Director of Test Development for National Computer Systems in Minneapolis, Minnesota where he is involved nationally with authentic assessment. A former elementary teacher and college professor, Dr. Dyches is actively involved in the National Council of Teachers of Mathematics and is a frequent speaker at workshops and conferences. Dr. Dyches attended the University of Alabama at Birmingham and Rutgers University and holds a doctoral degree in education.

Linda K. Griffith is Associate Professor of Mathematics and Computer Science at the University of Central Arkansas in Conway, Arkansas. She works primarily in the area of pre-service teacher education and in the masters degree program for teachers. Before completing her doctorate in mathematics education at the University of Texas in Austin, she taught in the Arkansas public schools. Dr. Griffith is committed to the implementation of the National Council of Teachers of Mathematics Standards and works in several grant-funded programs in support of their implementation.

Wayland Y. Brown is a priest of the Catholic Diocese of Savannah and an instructor of Mathematics and Computer Science at Georgia Southern University in Statesboro, Georgia. He teaches calculator-driven College Algebra and Trigonometry and Calculus using Macintosh computers with Mathematica. A graduate of the University of Washington, Father Brown is active in planning in-service workshops for teachers.

Marilyn S. Neil is Associate Professor of Education at West Georgia College in Carrollton, Georgia where she teaches graduate and undergraduate courses for prospective teachers. Dr. Neil is a frequent speaker at national and international conferences. She holds a doctoral degree from the University of Alabama.

COMMUNICATIONS

Teacher's Guide
Somewhere In Time

GOAL: To have students gain an understanding of a time capsule as a way of preserving history.

STUDENT OBJECTIVES:

- ✓ To make a time capsule.
- ✓ To investigate ways that things are preserved today to be discovered and studied in the future.

GUIDE TO THE INVESTIGATION: Discuss with students that sometimes people bury things in metal containers in the ground for people in the future to explore. The things placed in the containers, called time capsules, will let people in the future find out about the culture of the people who buried the time capsules.

Students need photographs, scrap book pages, tape or paste, markers, scissors, magazines, favorite toys or games, a shoe box or metal box and either ribbon, string, or yarn in order to make a time capsule.

This activity should be completed by individual students with the help of an adult.

Have students follow these instructions:

1. Gather pictures of yourself at birth, at one year, two years and yearly until now.
2. Glue or paste the pictures on scrapbook pages.
3. Get a front page from today's newspaper.
4. Cut photographs of your favorite foods, books, magazines, television programs, recording groups. Paste these on scrapbook pages.
5. Make a schedule of the things you do each day.
6. Place the photographs, pictures, the front page of the newspaper, your sched' e, and some of your favorite things in a shoe box. Tape the box closed with masking tape. Tie ribbon or yarn around the box.
7. Take the "time capsule" home and bury it in your closet.

Discuss the Observations and Conclusions.

VOCABULARY: time capsule, culture, preservation

Somewhere in Time

INTRODUCTION: A time capsule is a container that holds historical records or objects. These records or objects represent the current culture and are "buried" for preservation until they are discovered by a future age. In this activity you will make a time capsule.

PURPOSE:

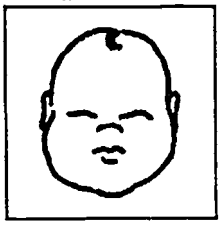
- ✓ What kinds of things are placed in a time capsule?
- ✓ How can you make a time capsule?
- ✓ How can the time capsule be used in the future?

MATERIALS:

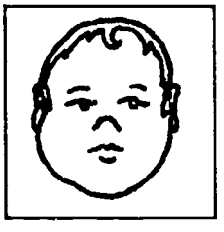
photographs
scrapbook pages
tape or paste
marker
scissors
magazines
favorite things such as toys, games
ribbon, string or yarn

PROCEDURES:

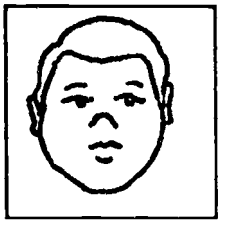
1. Have your mother or father help you find pictures of you when you were a baby less than a year old, when you were one year old, two years old, and at least one per year... until now.
2. Bring the pictures to school, and tape or paste the photographs on scrapbook pages. Label the pictures similar to these:



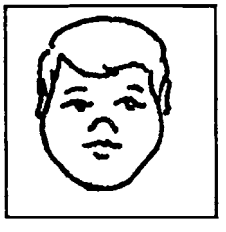
Birth
Jan. 2, 1985



Age - 1 year
1986



Age - 2 years
1987



Age - 3 years
1988

3. Find the front page of today's newspaper. Put the front page, showing today's date, with the photographs.
4. Cut some pictures from magazines that show your favorite foods, favorite books, games, records, television programs, recording groups, or other favorite things. Paste these pictures on other scrap book pages.
5. Make a list of the things you do each day and the time you do each thing.
6. Place the photographs, pictures, your list of things you do, and some "real things," such as toys that tell about you, in a shoe box or a metal box.
7. Tape the box on all sides. Tie the box with ribbon, string or yarn. Label the box with your name and this year (1994, 1995, ...). "Bury" your time capsule in a closet or other place at home for safe keeping. Do not open for several years!

OBSERVATIONS:

1. What special things did you place in your time capsule? ***Answers vary.***
2. What do you think that your time capsule will tell someone else about you? ***Answers vary.***

CONCLUSIONS:

1. Why do you think a "time capsule" is a good way to find out about the past? ***Answers vary.***
2. What kind of real things do you think would be good items to place in a time capsule so people 50 or 100 years from now will know exactly what life is like now? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Read or have your teacher read chapters from *This Book is About Time* by Marilyn Burns. Play a game of charades that is described in the first chapter of the book.

- Work with a partner. Write a story in which you describe what "long ago" means. Tell when "long ago" was and describe what happened "long ago". Who lived "long ago"? Are they still alive today?
- Read a book about dinosaurs. How have we found out about dinosaurs? How are fossils of dinosaurs like a time capsule? Make a drawing of a dinosaur. Share your drawing with your class. Discuss how we learned about dinosaurs.

Teacher's Guide
Mirror Magic

GOAL: To have students explore mirror images and make predictions of how mirror images will look.

STUDENT OBJECTIVES:

- ✓ To explore mirror images.
- ✓ To use mirrors to investigate images of various figures.
- ✓ To make predictions of how mirror images will look.

GUIDE TO THE INVESTIGATION: Have students discuss the uses of mirrors. Also have them look into small mirrors and describe what they see. Guide the discussion so students become aware of the fact that things on the left appear on the right and vice-versa in a mirror.

Students need cardboard or posterboard, scissors, two small rectangular mirrors, tape, paper, and pencil. Mirrors are taped together.

This exploration can be completed by individual students with the guidance of an adult, or older students can work together in small groups to make the shapes and use the mirrors to make mirror images.

Have the students follow these directions:

1. Cut the shapes from the cardboard.
2. Tape the mirrors together like a book cover, with the reflective sides facing each other.
3. Place the square between the mirrors, making sure the mirrors fit snugly around a corner of the square.
4. On the Response Sheet, draw a picture of what you see.
5. Try the same thing with the other shapes. Draw what you see in each image.

Discuss the Observations and Conclusions.

VOCABULARY: mirror image, reflection, parallelogram, hexagon, trapezoid

Mirror Magic

INTRODUCTION: When you look into a mirror you see a reflection. Your image looks exactly like you but it is changed in one way. In this activity you will use two mirrors taped together to investigate images and predict what happens to shapes when the two mirrors are used to make a reflection.

PURPOSE:

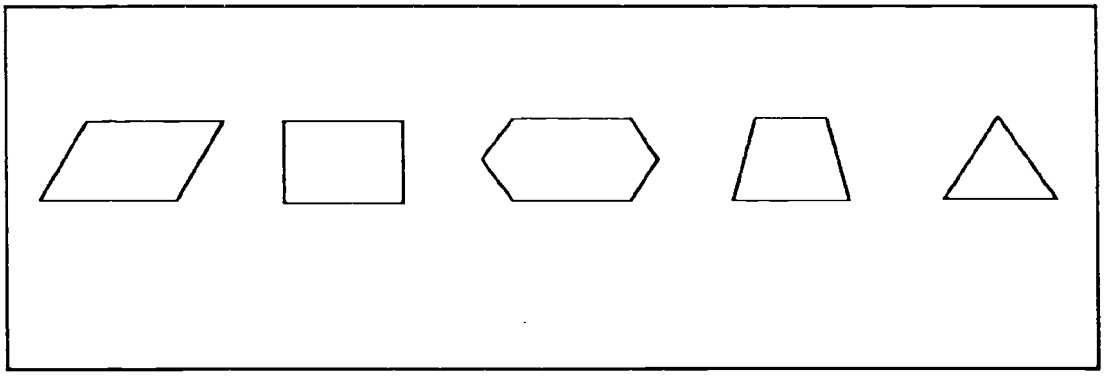
- ✓ What happens to a figure or shape when its image is reflected in a mirror?
- ✓ How are images changed when two mirrors are taped together and placed next to figures or shapes?

MATERIALS:

cardboard or poster board	tape
scissors	paper
2 small rectangular mirrors	pencil

PROCEDURES:

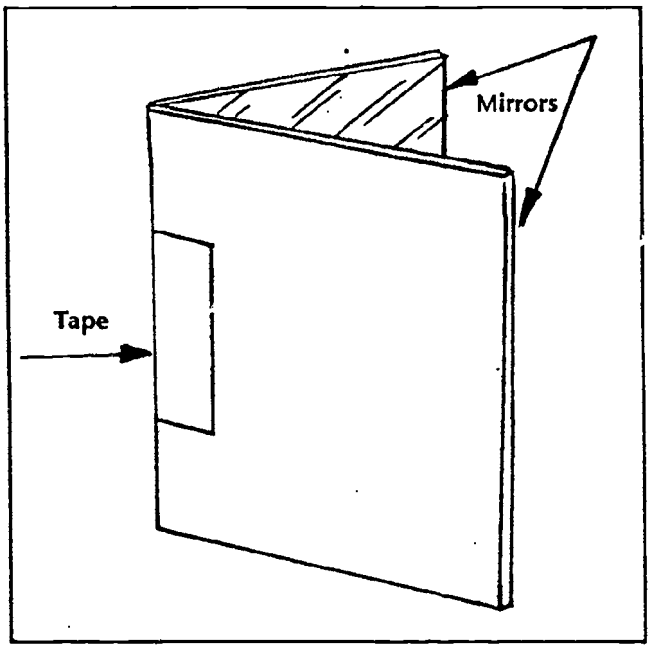
1. Draw these shapes on cardboard or poster board. Make them larger than shown. Use scissors to cut out each shape.



2 - 1 ***Parallelogram, square, hexagon, trapezoid, triangle***

2. Tape the mirrors together like a book cover, with the reflective sides facing each other (as shown in illustration 2 - 2).

3. Place a mirror beside each shape with the sides of the mirror touching the shape. What do you see ?
4. Place the square between the two mirrors that have been taped together. Make sure the mirrors fits snugly around the corner of the square.
5. Draw on the Response Sheet what you see — including the square and what you see in the mirrors.

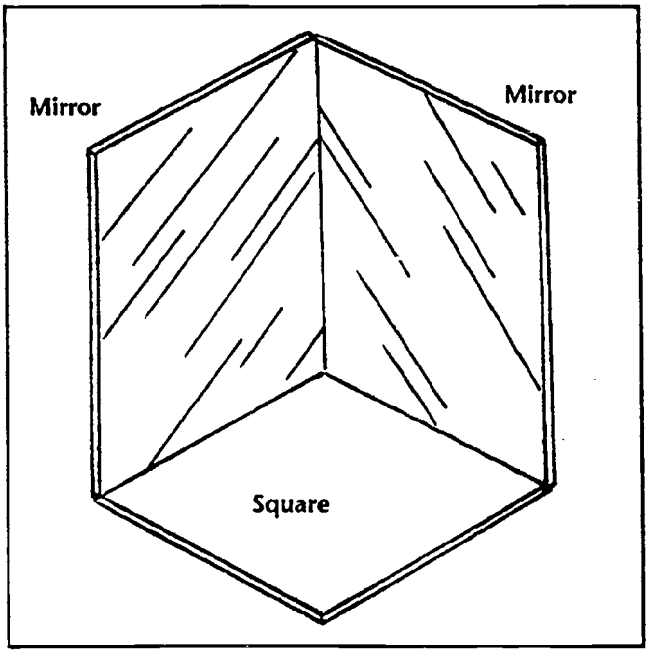


2 - 2 *Mirrors are taped together.*

6. Repeat the investigation on the other shapes.

OBSERVATIONS:

1. What did each of the shapes look like when you used one mirror to make an image? ***Images were reversed.***
2. How were the reflections different when you used the two mirrors taped together? ***Answers vary. Possible answer may be that there were two images.***



2 - 3 *Place the square between the mirrors.*

CONCLUSIONS:

1. Were you able to predict what the shapes looked like when you used one mirror to reflect them? ***Answers vary.***
2. What things did you learn about the mirror images when you used the two mirrors taped together to reflect an image? ***Answers vary.***
3. After trying the mirrors on one or two figures were you able to predict what you would see when you used the mirrors on the other shapes? ***Answers vary. Possible answers may be yes, there were two images or images were reversed.***

SUGGESTIONS FOR FURTHER STUDY:

- Use one mirror to reflect an image of pictures found in a magazine or a book. Then use the mirror to cover half of each picture. Which pictures were completed when you placed a mirror in the middle of the picture? Can you make a "whole" picture by placing a mirror in the middle of all pictures? Why or why not? ***Answers vary.***
- On one index card draw one-half of a picture of a sun with rays. On other cards draw one-half of a leaf, a glass, a bowl and a cup. Place a mirror on each "half" picture. Are the pictures now "whole"? If not, change your drawing so the mirror makes a "whole" picture. Trade cards with a friend. Can you make whole pictures using a mirror on your friends drawing? ***Answers vary.***
  Possible answer may be yes, usually you can make a "whole" picture if the object is symmetrical.

Response Sheet
Mirror Magic

What I see when I use the two mirrors on:

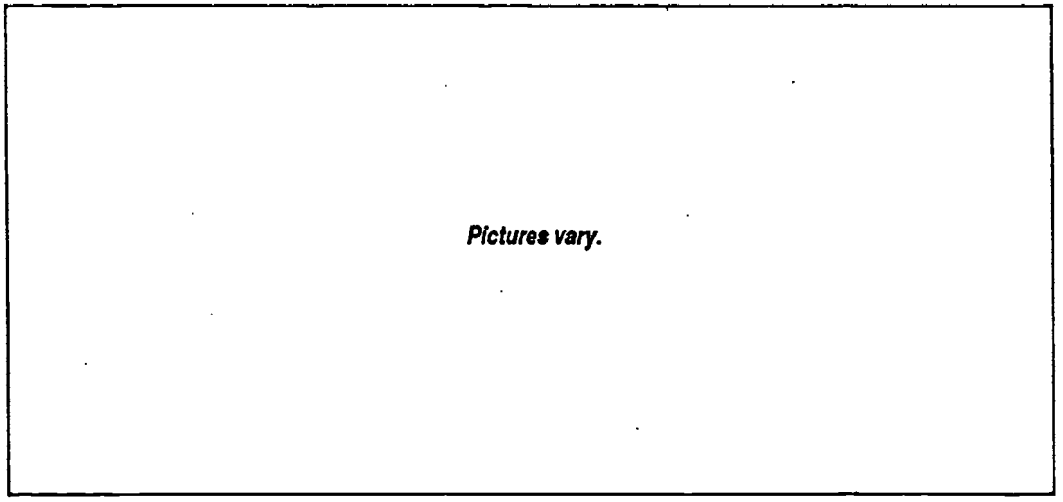
1. The square:

Pictures vary.

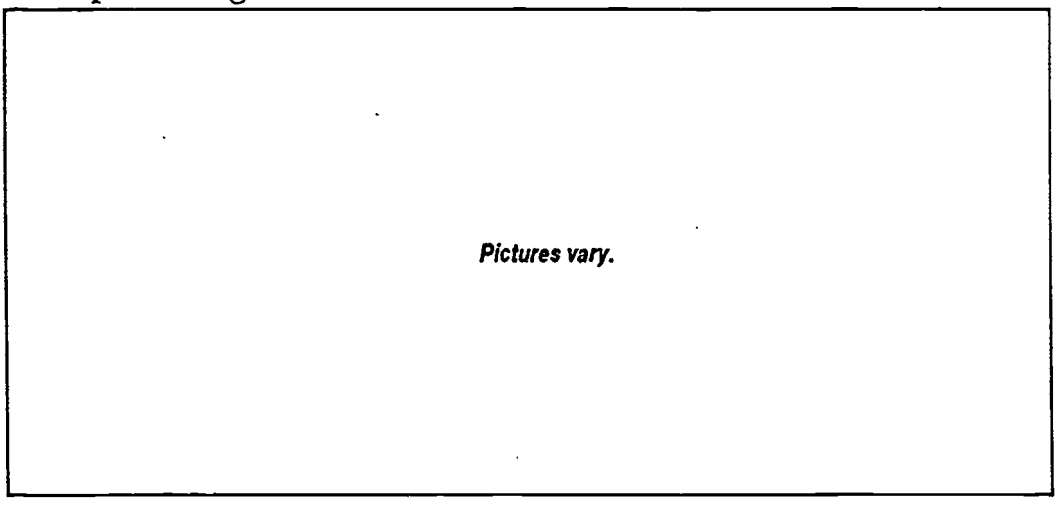
2. The triangle:

Pictures vary.

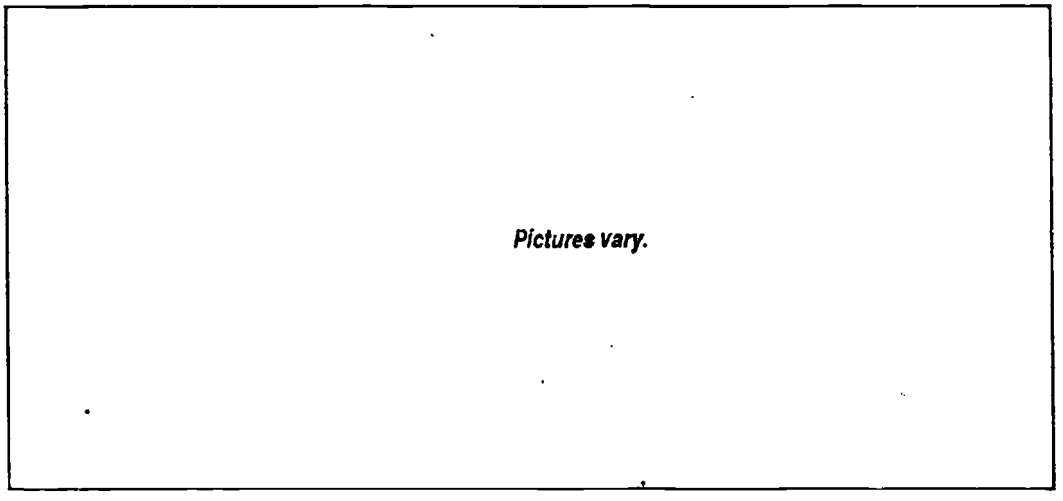
3. The hexagon:



4. The parallelogram:



5. The trapezoid:



Teacher's Guide
Making a Measuring Cup

GOAL: To have students make a measuring cup and explore measuring capacity using milliliters.

STUDENT OBJECTIVES:

- ✓ To make a measuring cup.
- ✓ To measure capacity in milliliters.

GUIDE TO THE INVESTIGATION: Display measuring spoons and measuring cups that are calibrated in milliliters. Discuss the small amount in a milliliter and why measuring cups are marked in calibrations of about 20 or 30 milliliters.

Students need a large clear plastic cup, masking tape, a ball-point pen, a milliliter measuring cup, a bowl, and a 15 milliliter measuring spoon.

This activity can be conducted by individual students or pairs of students. Younger students may need adult supervision.

Students should follow these directions:

1. Place tape down the side of a clear plastic cup.
2. Carefully fill a 15 milliliter measuring spoon with water. Pour the water into the clear plastic cup. Fill the spoon again and pour into the cup.
3. Look at the water at eye level. Make a mark on the tape. (See drawing.)
4. Repeat this process until the cup is almost full, marking 30 milliliter intervals on the tape.
5. Mark "mL" at the top.
6. Test the measurements marked on the cup by pouring the water into a standard milliliter measuring cup. The amount poured from the "home-made" measuring cup should fill the standard measuring cup to about the same height.
7. Use the cup to measure each liquid you drink in a day. Guess how many milliliters you drink in one sip. Test this by filling your clean cup with a liquid (milk, water, etc.). Take a sip. Read the cup measure again. Decide how many milliliters you drink in one sip.

Discuss the Observations and Conclusions.

VOCABULARY: calibrate, milliliters, capacity, intervals

Making a Measuring Cup

INTRODUCTION: It is possible to make a measuring device by calibrating a large measure into smaller equal parts. In this activity you will make a calibrated measuring device to measure capacity. You will then use the calibrated device to measure various amounts.

PURPOSE:

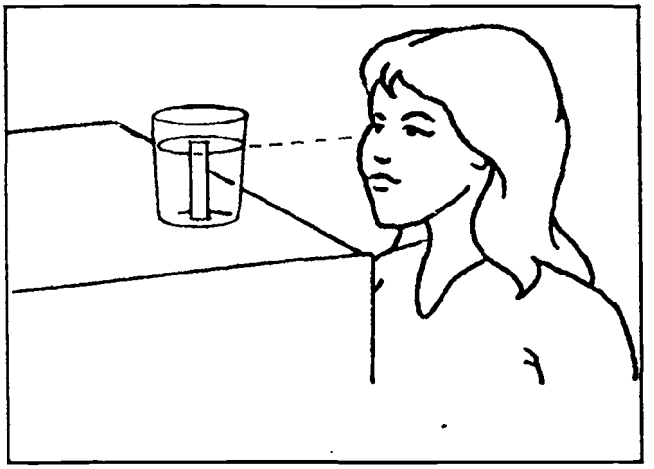
- ✓ What are the characteristics of a device for measuring capacity?
- ✓ How can a calibrated device be made?
- ✓ How can the device be used to measure capacity?

MATERIALS:

large clear plastic cup
masking tape
ball point pen
15 milliliter measuring spoon
milliliter measuring cup

PROCEDURES:

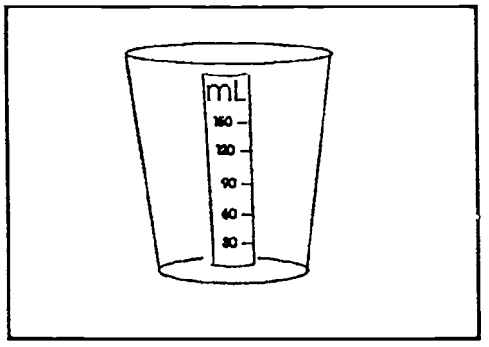
1. Place tape down the side of a clear plastic cup.
2. Use a 15 milliliter measuring spoon. Carefully fill the spoon with water. Pour the water into your clear plastic cup. Fill the spoon again and pour it into the cup.
3. Look at the water at eye level. Make a mark on the tape at the top of the water.



3 - 1 *Look at the water at eye level. Make a mark.*

4. Repeat the same process until the cup is almost full.

5. Mark the 30 milliliter intervals where you made marks on the cup. Mark "mL" at the top of the cup. (See illustration 3-2.)



3 - 2 *Mark the 30 millileter intervals where you made marks on the cup. Mark "mL" at the top.*

6. Test the measurements marked on the cup by pouring the water into a standard milliliter measuring cup. The amount poured from your "homemade" measuring cup should fill the standard milliliter measuring cup to about the same height as in your measuring cup.

7. Use the cup you made to measure each liquid you drink in one day. Guess how many milliliters you drink in one sip. Test this by filling your clear cup with a liquid (milk, water, etc.). Take a sip. Read the cup measure again. Decide how many milliliters you drank in one sip.

OBSERVATIONS:

1. Were you able to make the measuring cup and mark it in milliliters? Why or why not? ***Answers vary.***

2. Was the capacity of your home-made measuring cup accurate? How did you find out? ***Answers vary.***

CONCLUSIONS:

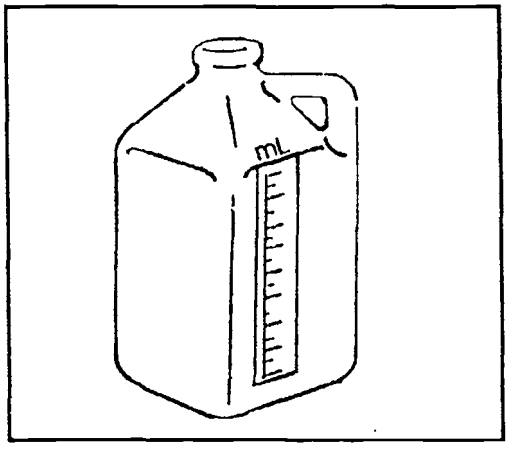
1. What are some ways you might use your measuring cup? ***Answers vary.***

2. What are "real world" uses of a calibrated cup such as the one you made? ***Answers vary. Possible answers may be in cooking, for cough syrup, etc.***

3. Why is there a need for accurate measures of capacity? ***Answers vary. Possible answers may be it is needed in recipes to make the food come out right; to make sure you take the right amount of medicine.***

SUGGESTIONS FOR FURTHER STUDY:

- Calibrate a plastic milk jug in 250 mL or 500 mL intervals. Use it to measure the water you use for plants or the water you set out for a pet to drink. Think of other things to do with your measuring cup and jug.



3 - 3 *Calibrate a plastic milk jug in 250 mL or 500 mL intervals.*

- Examine the measuring spoons and cups your family uses at home. Do you use teaspoons, tablespoons and cups or do you use milliliter and liter containers? Ask why your family uses the ones it uses. ***Answers vary.***

Teacher's Guide
The Loop: A Simple Closed Figure

GOAL: To have students explore using everyday items, such as thumbtacks and yarn, to make curved shapes.

STUDENT OBJECTIVES:

- ✓ To explore making curved figures.
- ✓ To identify closed curves and other curved figures.

GUIDE TO THE INVESTIGATION: Discuss with students that a circle is a curve and a curve can be drawn on paper without lifting the pencil. Also discuss that when a curve has no end points, it is a closed curve and that a circle is a simple closed curve.

Students need a 12 inch piece of yarn or string, 3 or 4 thumbtacks, a piece of cardboard, and a pencil.

This activity can be completed by individual students with the assistance of an adult.

Demonstrate using the yarn, pencil, cardboard, and a thumbtack to make a curved shape. Have students practice making curved lines and shapes with one thumbtack before completing these directions:

1. Make a loop using the yarn. Stick a thumbtack into a piece of cardboard. Place the loop around the tack. Stretch the yarn as tight as you can without pulling the thumbtack from the cardboard. Place a pencil in the yarn and trace a shape with the loop while it is stretched tight (see illustration 4 - 1). Make drawings on the Response Sheet that show two shapes you made.
2. Repeat the procedure using two thumbtacks. Draw two figures you made.
3. Repeat the procedure using three thumbtacks. Draw two figures you made.

Discuss the Observations and Conclusions.

VOCABULARY: circle, curve, closed curve, simple closed curve

The Loop: A Simple Closed Curve

INTRODUCTION: Have you ever seen a river while looking from an airplane window or from the top of a tall mountain? A river runs along in a curvy pattern, sometimes almost meeting itself when it curves. In this activity you will make some drawings of simple curves, some that look like a winding river.

PURPOSE:

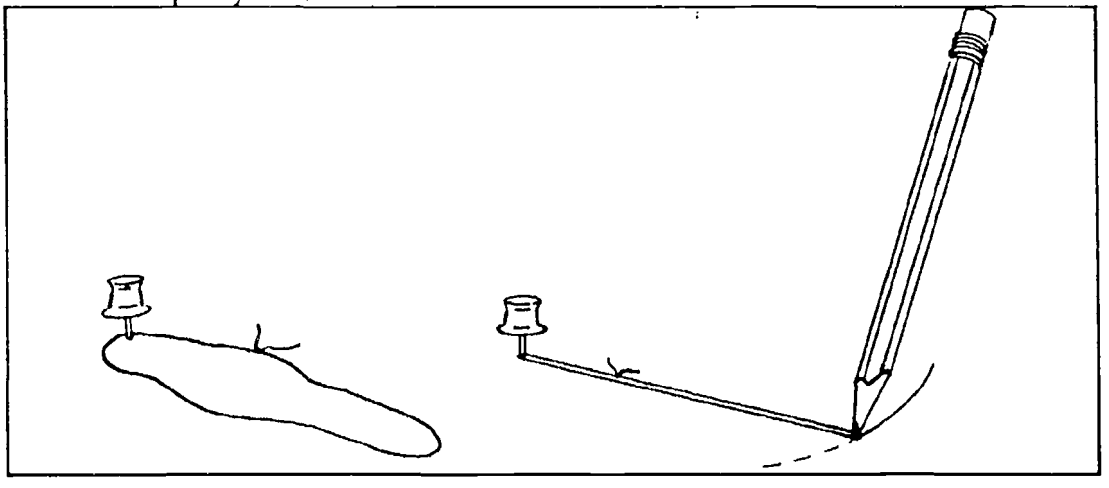
- ✓ What are some ways to make curved figures?
- ✓ What is a simple closed curve?

MATERIALS:

12 inch piece of yarn or string	piece of cardboard
3 or 4 thumbtacks	pencil

PROCEDURES:

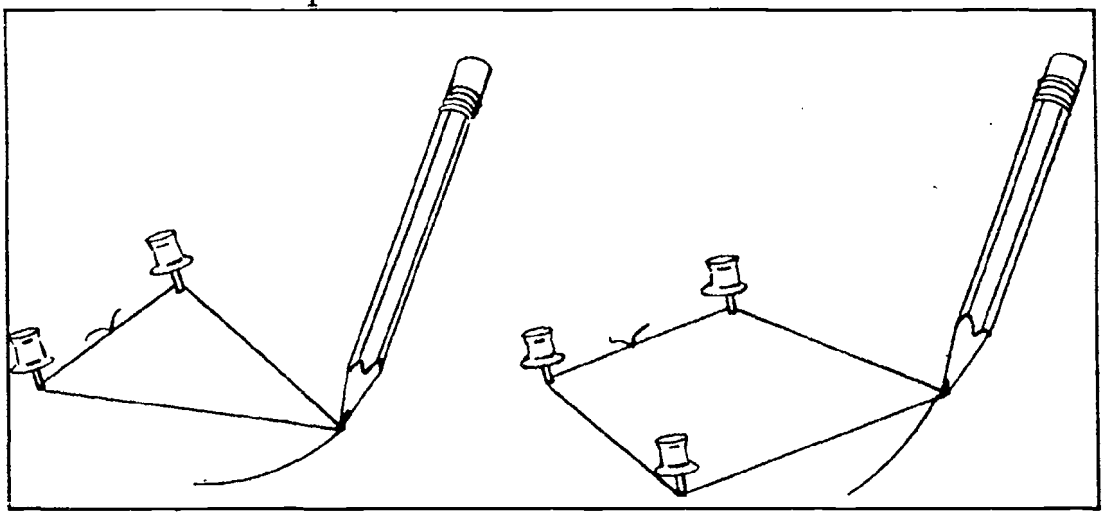
1. Make a loop using the yarn. Stick a thumbtack into a piece of cardboard. Place the loop around the tack. Stretch the yarn as tight as you can without pulling the thumbtack from the cardboard. Place the pencil in the yarn and trace a shape with the loop while it is stretched tight. Make drawings on the Response Sheet that show two shapes you made.



4 - 1

2. Repeat the procedure using two thumbtacks. Draw two figures you made on the Response Sheet.

3. Repeat the procedure using three thumbtacks. Draw two figures you made on the Response Sheet.



4 - 2

4. Write a paragraph describing the figures you made.

OBSERVATIONS:

1. What curved figures did you make with one thumbtack, two thumbtacks, and three thumbtacks? ***Answers vary.***

2. Which of these figures are simple closed curves? Why? ***All are because the lines do not cross.***

CONCLUSIONS:

1. Were you able to make figures that are not simple closed figures using one, two, or three thumbtacks? How? ***Answers vary.***

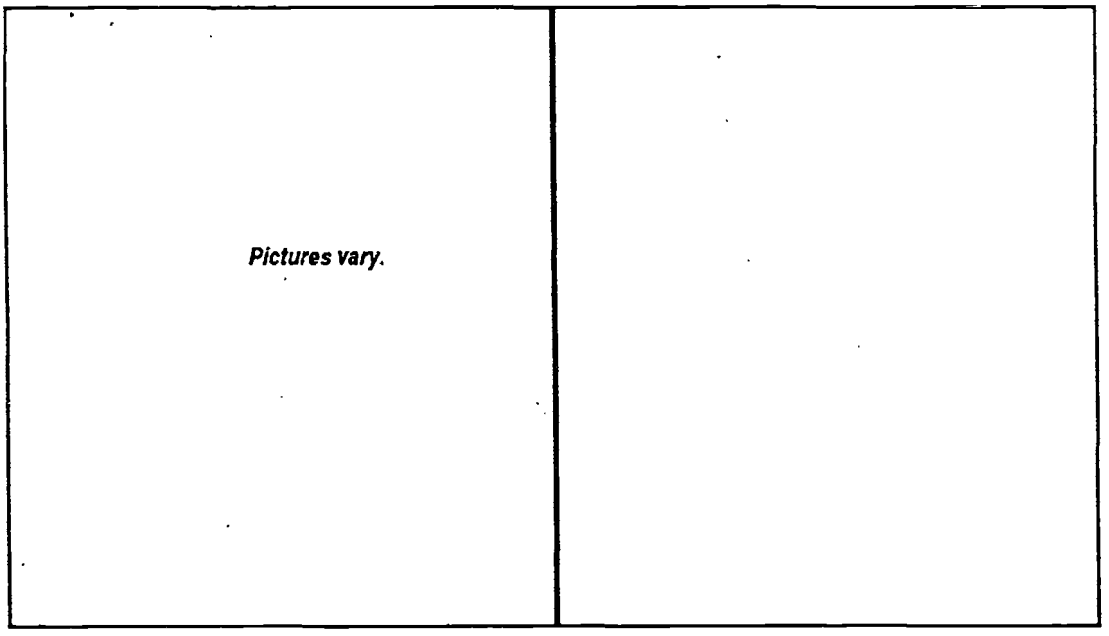
2. What rule can you make about the kinds of figures you can make using one, two, or three thumbtacks? ***Answers vary. Possible answer may touch on a relationship between the number of thumbtacks and the size of the figure.***

SUGGESTIONS FOR FURTHER STUDY:

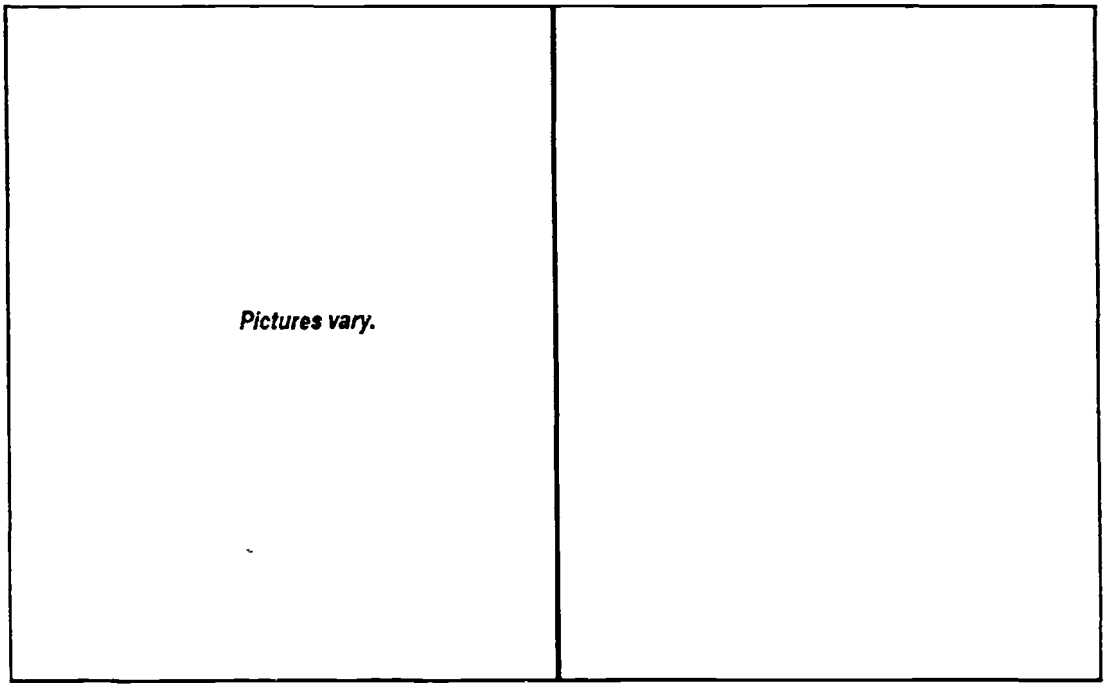
- Use two tacks, your pencil and yarn. Make as many different simple closed curves as you can by moving the tacks. Make a drawing of the shapes you make using the yarn, pencil, and two tacks. Then try to place the two tacks and yarn to make the same shape as when you use only one tack, pencil or yarn.
- Draw and color a picture on an 11" by 14" sheet of poster board. Use a black marker or felt tip pen to make a picture puzzle by drawing simple closed curves on the picture. Then use heavy scissors to cut out the puzzle. Exchange with another student. Try to put the other student's puzzle together.

Response Sheet
The Loop: A Simple Closed Figure

Draw the shapes you made using one thumbtack.



Draw the shapes you made using two thumbtacks.



Draw the shapes you made using three thumbtacks.

Pictures vary.	

Teacher's Guide
What's My Area?

GOAL: To have students gain an understanding of area by investigating shapes on a geoboard.

STUDENT OBJECTIVES:

- ✓ To construct a geoboard.
- ✓ To find the area of several shapes on a geoboard.

GUIDE TO THE INVESTIGATION: Discuss with students about tiles and floor covering and the squares found in the floor tile of the classroom, lunchroom, or rooms at home. Explain that when covering the floor with tiles you find the area of the floor.

Students need a 10 inch square of wood (one-half to one inch thick), a hammer, a ruler, 25 small finishing nails, a pencil, and about 20 rubber bands.

Each student should make his own geoboard with the assistance of an adult. Once the geoboards are completed, students can work in pairs to complete the investigations of area. (If students made geoboards in activity 15, the *Georimeter* investigation, they can be used in this investigation.)

Have students follow these directions:

1. Measure and draw lines on the board as shown in the drawing.
2. Use a hammer to drive the nails partially into the wood where the two lines cross (at the intersection of the lines.)
3. Use rubber bands to copy the design shown in the second drawing onto the geoboard. (The area of one square on the geoboard is one square unit.)
4. Find the area of the entire design and each shape inside the design you made when you used rubber bands on your geoboard. Record the area of each shape on the Response Sheet.
5. Remove the rubber bands from the geoboard. Make some original designs on the geoboard using several rubber bands. Copy the design on the geoboard onto the Response Sheet. Count the squares to find the area of each shape you made on the geoboard.

Discuss the Observations and Conclusions.

VOCABULARY: area, space, geoboard

What's My Area?

INTRODUCTION: Have you ever worked with a geoboard? A geoboard enables you to explore polygons; find the perimeter of polygons and the area of polygons. In this activity you will make a geoboard and investigate the area of several shapes. Area is the space that is covered on a surface.

PURPOSE:

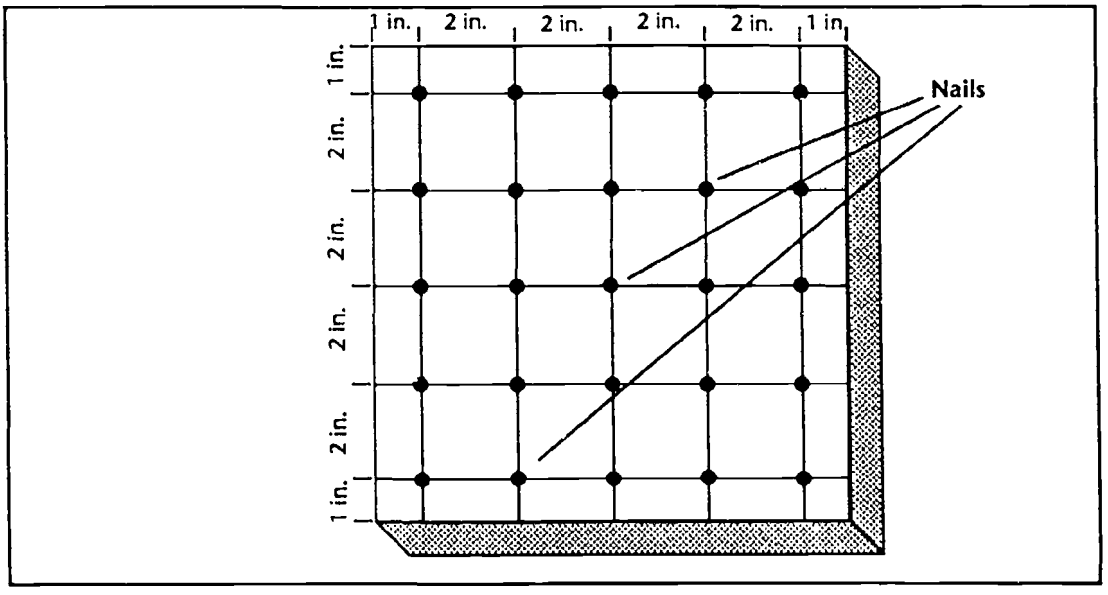
- ✓ How do you construct a geoboard?
- ✓ How can a geoboard help you understand area?

MATERIALS:

25 finishing nails
ruler
a 10 inch square of wood (1/2 to 1 inch thick)
pencil
hammer
20 rubber bands

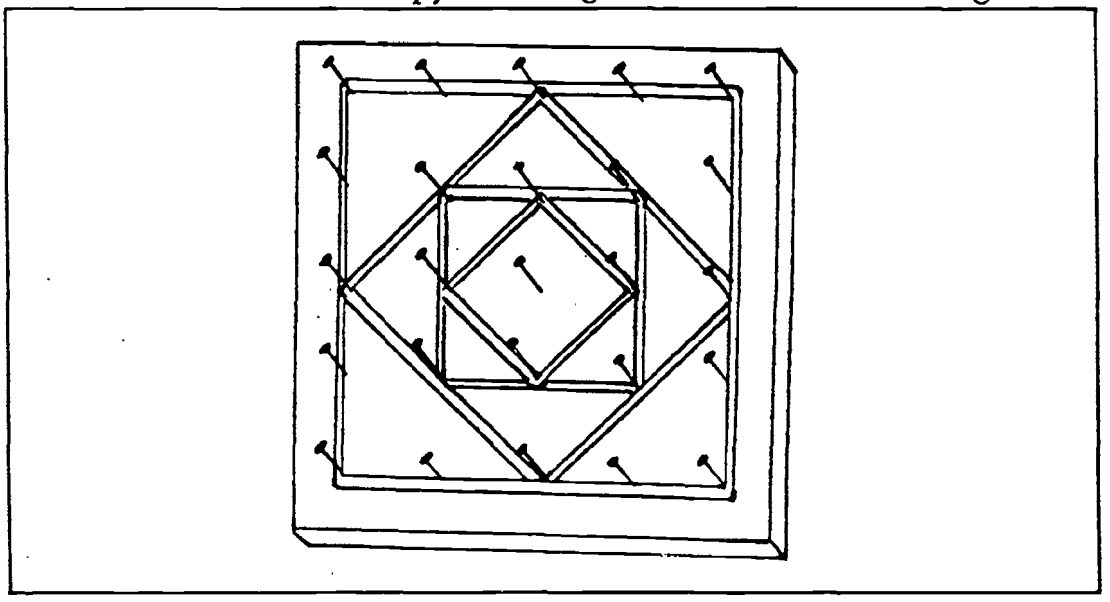
PROCEDURES:

1. Measure and draw lines on the board as shown in illustration 5–1.



5 - 1

2. Use a hammer to drive the nails partially into the wood at each point where two lines cross (at the intersection of the lines).
3. Use rubber bands to copy the design shown on this drawing:



5 - 2 Design on a geoboard

4. Find the area of the entire design and the area of each shape inside the design you made on your geoboard. The area of one square on the geoboard is one square unit. On the Response Sheet , record the area of each of the shapes within the design (the square and the triangles).
5. Remove the rubber bands from the geoboard. Make some original designs on the geoboard using several rubber bands. Copy the designs you made on the geoboard onto the Response Sheet. Count the number of squares to find the area of each shape you made on the geoboard.

OBSERVATIONS:

1. What is the area of each of the small squares you made? ***Two square units***
2. What are the areas of the larger squares? ***Four square units; eight square units; sixteen square units***
3. What is the area of the triangles? ***½ square unit; one square unit***

CONCLUSIONS:

1. Can you find the area of any shape made on the geoboard ? ***Answers vary.***

2. How were you able to figure out the area of the small triangles on the geoboard? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Cut 12 or more one foot squares from posterboard or cardboard. Take the cardboard squares to the playground or the parking lot and use chalk (on the parking lot) or a stick (on the dirt of the playground) to draw a large square, a large rectangle and a large triangle. Estimate the number of cardboard squares it will take to cover the square, rectangle and triangle. Then place your squares on the ground or sidewalk to cover the shapes and to find the area of the three polygons. Were your estimates close? What did you have to do to measure the "angles" of the triangle? Discuss what you did with a friend. ***Answers vary.***

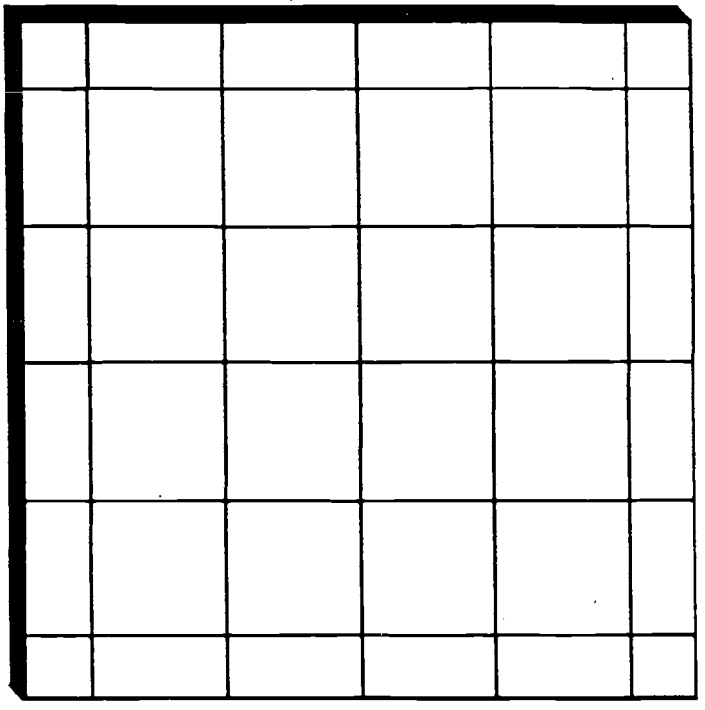
Response Sheet
What's My Area?

Areas:

1. The smallest center square ___2___ square units.
2. The next larger square ___4___ square units.
3. The third largest square ___8___ square units.
4. The largest square ___16___ square units.
5. The smallest triangles ___1/2___ square units.
6. The largest triangles ___1___ square unit.

My Own Design

Designs vary.



Area of the figures in my design:

Name of Figure	Area
Answers vary.	

Teacher's Guide
Shape Mobile

GOAL: To have students explore making mobiles that balance using two-dimensional shapes.

STUDENT OBJECTIVES:

- ✓ To copy two-dimensional shapes.
- ✓ To arrange two-dimensional shapes on a mobile so that the mobile balances.

GUIDE TO THE INVESTIGATION: Show examples of mobiles. Discuss with students where they might have seen mobiles.

Students need pencils, paper, crayons or markers, lightweight cardboard, glue, a hole punch, and yarn or heavy thread for this activity.

This activity may be conducted by individual students with the guidance of an adult.

Have students follow these directions:

1. Make a shape mobile from one large and four small shapes (rectangles, circles, or triangles).
2. Draw and cut out one large and four small shapes.
3. Use the crayons or markers to color the shapes.
4. Use a hole punch to punch holes in the smaller shapes.
5. Use yarn or heavy thread to tie the shapes together (see illustration 6–1).
6. Hang the mobile and adjust the placement of the shapes until it hangs "balanced".
7. Make other mobiles using different shapes.

Discuss the Observations and Conclusions.

VOCABULARY: two-dimensional, mobile

Shape Mobile

INTRODUCTION: Many shapes are found in the environment. Often we see mobiles containing shapes and/or pictures hanging from ceilings in stores or office buildings. A mobile that has several different shaped objects hanging must be carefully constructed in order to balance. In this activity you will make a shape mobile that balances.

PURPOSE:

- ✓ How can two-dimensional shapes be arranged to make a mobile that balances?
- ✓ Which shapes are easier to use to make a mobile that balances? Why?

MATERIALS:

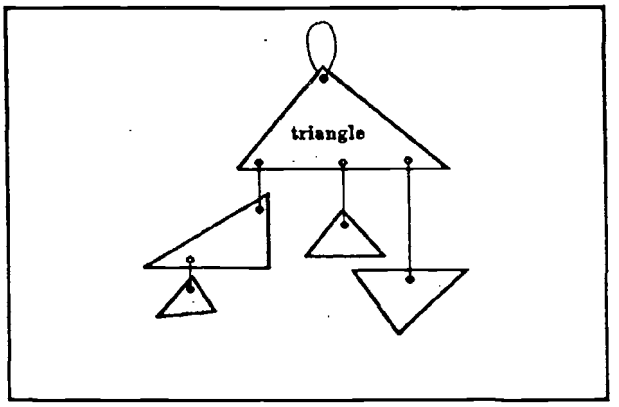
pencil
paper
crayons or markers
lightweight cardboard
glue
hole punch
yarn or heavy thread

PROCEDURES:

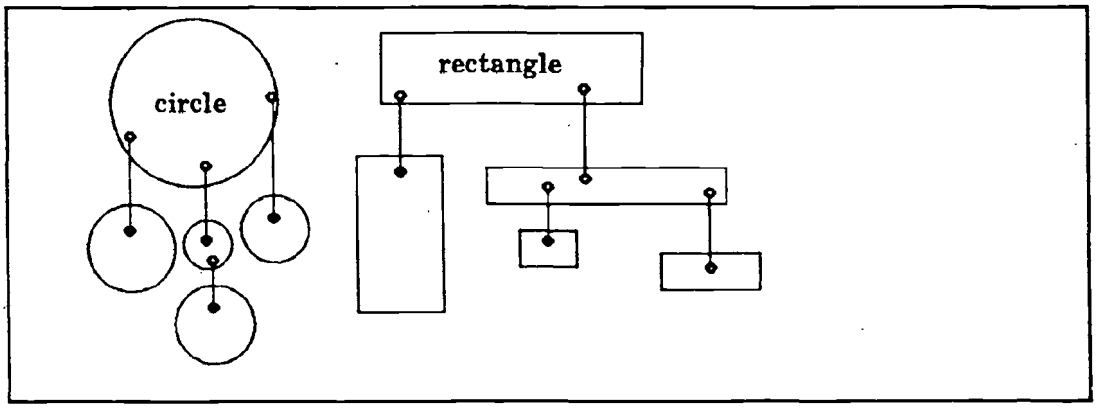
1. Make a shape mobile. Make your mobile from one large and at least 4 smaller shapes of the same kind– triangles, circles, squares or rectangles.
2. To make a triangular mobile, draw and cut out a large triangle from cardboard.
3. Then cut at least 4 smaller triangles from cardboard.
4. Color all the triangles with crayons or markers.
5. Use a hole punch to punch holes in the smaller triangles.

6. Use yarn or heavy thread to tie the triangles to the large triangle as shown in illustration 6-1. Be sure the mobile hangs straight.

7. Make other mobiles with circles, rectangles, and other shapes. Try using more than four smaller shapes for each mobile.



6 - 1 *Triangle mobile*



6 - 2 *Circle and rectangle mobiles*

OBSERVATIONS:

1. Were you able to make a balanced mobile from the shapes? ***Answers vary.***

2. What did you have to do to make a balanced mobile? ***Answers vary.***

CONCLUSIONS:

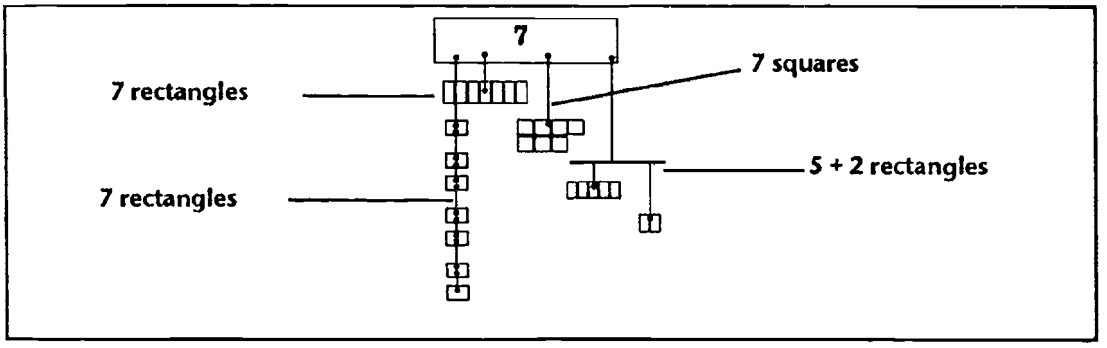
1. What things did you consider about balancing before you punched holes in the smaller shapes? ***Answers vary. Possible answer may be that you must place the same number of shapes on each side of the large shape.***

2. What did you have to do to some shapes if your mobile was not balanced? ***Answers vary. Possible answer may be to move them around.***

3. What are other things to consider when making a mobile from other materials, such as paper or wood? ***Answers vary.***

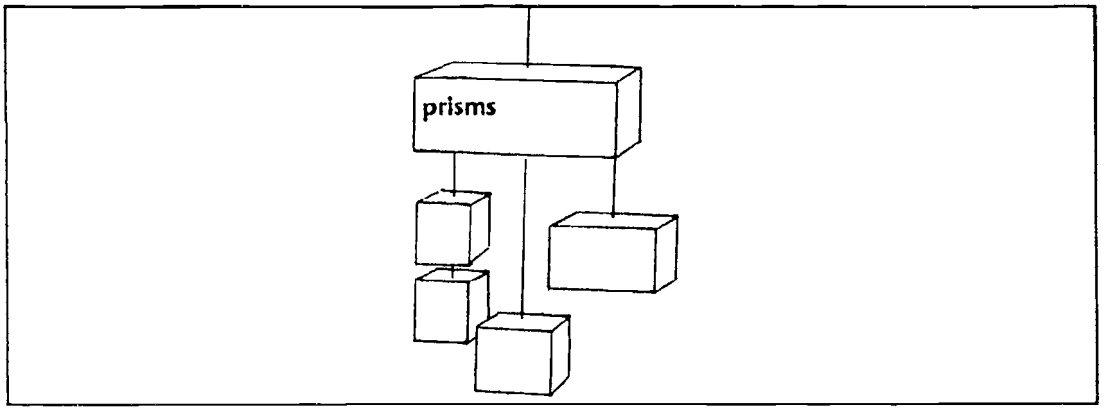
SUGGESTIONS FOR FURTHER STUDY:

- Make mobiles that show numbers of squares or rectangles rather than geometric figures.



6 - 3 *Number mobile*

- Try making mobiles by suspending three-dimensional figures such as rectangles, prisms, or triangular prisms using string or yarn.



6 - 4 *Rectangular prism mobile*

SPATIAL SENSE

Teacher's Guide
Tangram Puzzles

GOAL: To have students make a tangram puzzle and explore making various shapes using the puzzle parts.

STUDENT OBJECTIVES:

- ✓ To make a tangram puzzle.
- ✓ To explore using tangram puzzles to make various shapes.

GUIDE TO THE INVESTIGATION: Tell the story about the Chinese man who had a beautiful tile. When he walked through a garden the tile fell and broke into seven pieces. These seven pieces became known as tangram puzzles. The Chinese man spent many years trying to put the tile together in its original design.

Students should work in pairs or small groups to cut tangram puzzles from construction paper or posterboard. In addition to the paper, board, and scissors, students need a ruler and a pencil. Younger students may need individual help in measuring and cutting tangram pieces.

1. Direct students to measure the paper or board and cut the seven tangram pieces as shown on the Procedures section of this exploration.
2. Have students follow the directions in the Procedures section to make the tangram puzzle pieces.
3. Then have students use the seven tangram puzzle pieces to make the rectangle and the triangle shown on the Response Sheet.
4. Next students should make the two small squares shown on the Response Sheet using all seven pieces.
5. Have the students sketch the drawing on the Response Sheet.

Students should be allowed plenty of time to use the tangram puzzle pieces to make the rectangle, triangle and two small squares. (Store puzzle pieces in a plastic bag.) Allow students to explore with the puzzle whenever they choose.

Discuss the Observation and Conclusion questions when students have explored the puzzles.

VOCABULARY: tangram, centimeter, rectangle, triangle, polygon

Tangram Puzzles

INTRODUCTION: In this activity you will make a tangram puzzle. A tangram is a square puzzle made of seven pieces—two large triangles, one medium sized triangle, two small triangles, a square, and a parallelogram. The seven tangram pieces can be put together in many different ways to make many different designs.

PURPOSE:

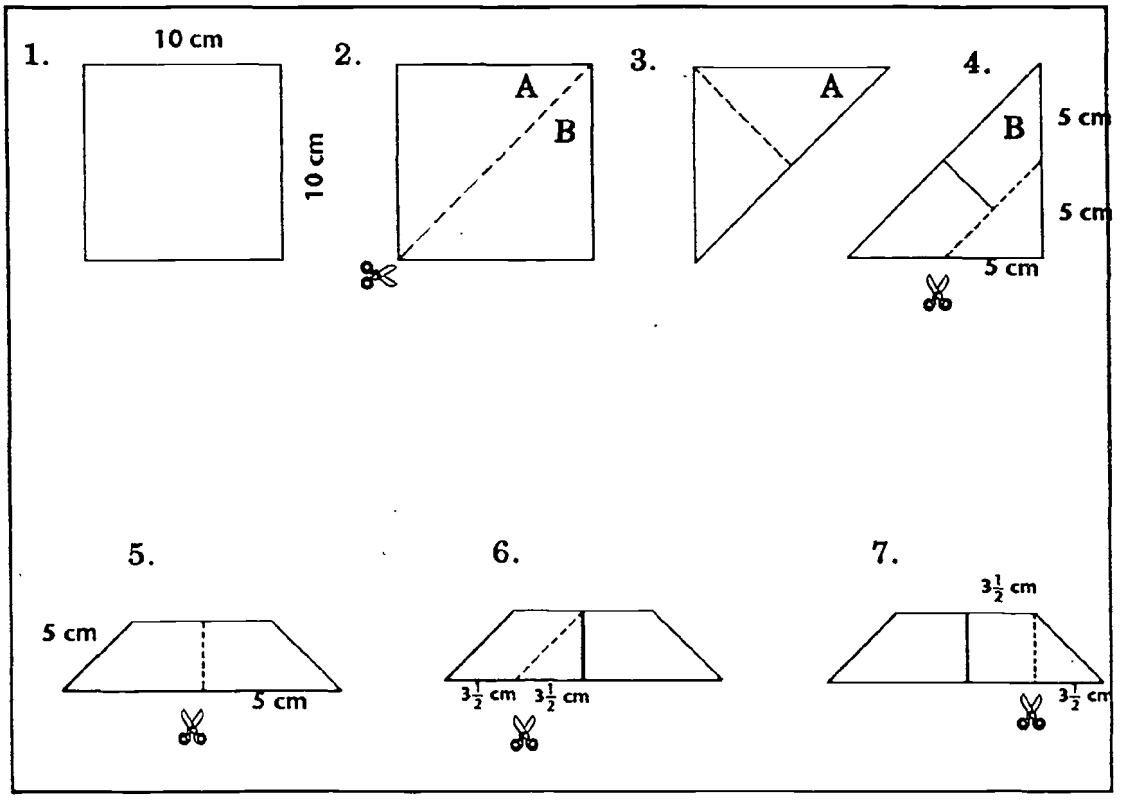
- ✓ How can you make a tangram puzzle?
- ✓ What kinds of shapes can be made by rearranging the seven pieces of a tangram puzzle?

MATERIALS:

ruler
pencil
construction paper or posterboard
scissors

PROCEDURES:

1. Make a tangram puzzle. Use a sheet of colored construction paper or posterboard. Cut a square 10 centimeters on each side.
2. Fold and cut the square into seven pieces as shown in illustration 7-1 on the next page.
3. Use the pieces of the tangram puzzle to make the rectangle and the triangle shown on the Response Sheet.
4. Then make small squares two different ways. Cover the squares shown on the Response Sheet one way with 4 tangram pieces, and in another arrangement with 5 tangram pieces. Draw a sketch showing how the tangram pieces fit to make the two squares.



7 - 1 Steps for making the tangram puzzle

OBSERVATIONS:

1. Were you able to make each of the shapes? ***Answers vary.***
2. Which was harder to make, the rectangle, the triangle, or the two squares? ***Answers vary.***
3. Would it be easier to make shapes using only the five small pieces? ***Answers vary.***

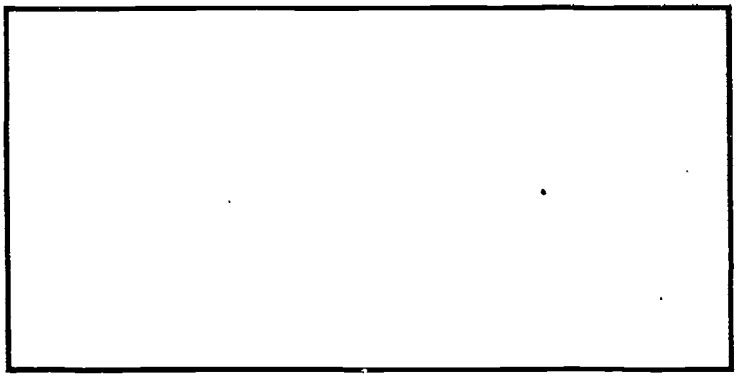
CONCLUSIONS:

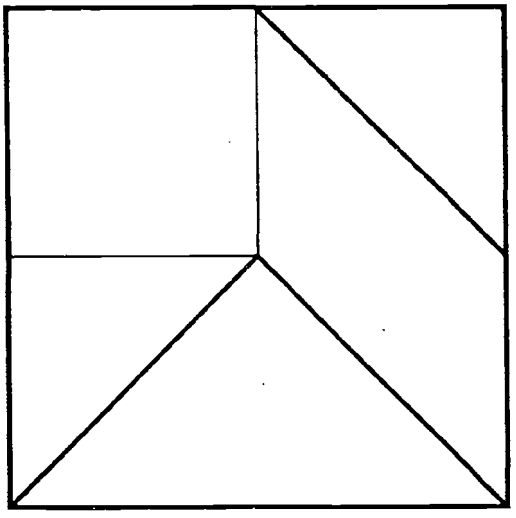
1. Could you make any of the shapes without using all seven puzzle pieces? ***Yes.***
2. When you used all seven puzzle pieces to make the rectangle, the triangle, or the two squares, was the same amount of space covered for each shape? Why do you think so? ***Yes, you used the same pieces for each shape.***

SUGGESTIONS FOR FURTHER STUDY:

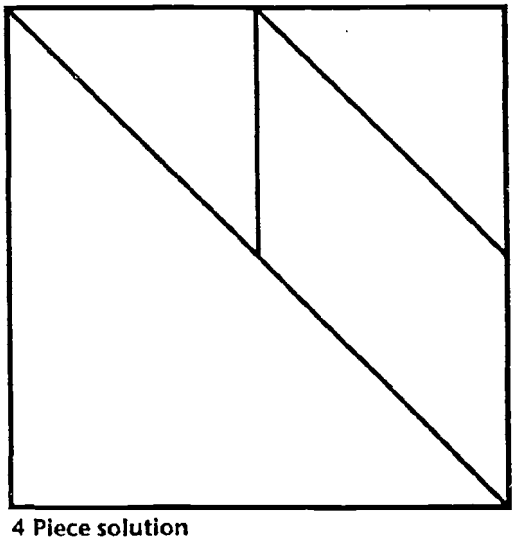
- Use the seven tangram pieces. Make them into a design showing a boat, a house, a car, and an animal. Which animal did you make? Make a drawing showing where you placed the puzzle pieces when you made the boat, the house, the car and the animal.
- Make designs or shapes using 3, 4, 5, 6, or 7 of the tangram puzzle pieces. Draw the outside shape of the design on an index card. Draw which pieces you used to make the design or shape. Trade cards with a partner. Try to make his design or shape while he tries to make yours.

Response Sheet
Tangram Puzzles

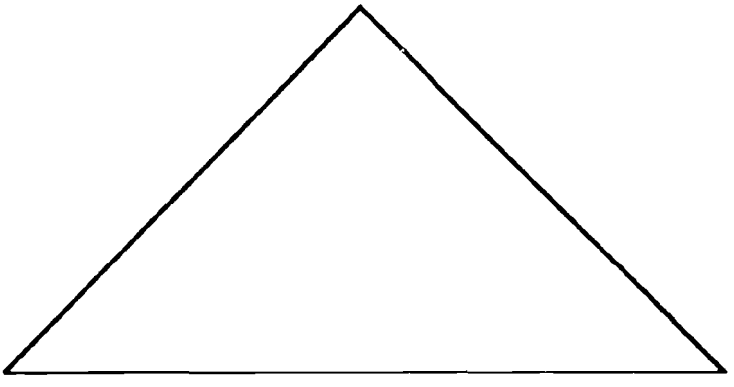




5 Piece solution



4 Piece solution



Teacher's Guide
Creating Cubes From Squares

GOAL: To have students explore folding squares that are cut from centimeter square paper to make cubes and gain an understanding of the cube and three-dimensional shapes.

STUDENT OBJECTIVES:

- ✓ To cut patterns from centimeter grid paper.
- ✓ To fold squares to create cubes.

GUIDE TO THE INVESTIGATION: Discuss with students that we live in a three-dimensional world. Describe several three-dimensional shapes (cubes, cylinders, triangular prisms). Have students look around the room and identify any three-dimensional shapes they may see. (Be sure there is a cube displayed.)

Students need centimeter grid paper (included), a pencil, scissors, and tape for this exploration.

This activity can be carried out by individual students with the assistance of an adult. Older students may complete the activity in small groups.

Have students follow the directions in the Procedures section.

1. Cut out the pattern shown on the centimeter grid paper.
2. Fold the pattern to make a cube. Tape the cube together.
3. Outline four other patterns of six connected squares on the centimeter grid paper. Make patterns that you think will make a cube when they are cut out and taped together.
4. Cut out the patterns. Fold them as you folded the first one to see if they make a cube. If they do, tape the edges together.
5. Make a drawing on the Response Sheet showing the patterns you made and cut out. Record whether or not each pattern made a cube when folded.

Discuss the Observations and Conclusions.

VOCABULARY: three-dimensional, cube, centimeter squares, pattern, faces

Creating Cubes From Squares

INTRODUCTION: Many things in our environment have the shape of cubes. You know that a cube has six faces. Each face of a cube is a square. In this activity you will outline six squares on centimeter square paper and cut them out. You will try to fold and tape the squares into a cube.

PURPOSE:

- ✓ How many connected squares are needed to be folded to make a cube?
- ✓ Which patterns of connected squares can be folded to make a cube?

MATERIALS:

grid paper (included)
pencil
scissors
tape

PROCEDURES:

1. Cut out the pattern shown on the grid paper.
2. Fold the pattern to make a cube. Tape the cube together.
3. Outline four other patterns of six squares on the grid paper. Make patterns that you think will make a cube when they are cut out and taped together.
4. Cut out the four patterns. Try to fold them into cubes. Tape the edges together if they make a cube.
5. Make a drawing on the Response Sheet of the patterns you made and cut out. Record whether or not the patterns made a cube. The original pattern has been drawn for you.

OBSERVATIONS:

1. How many square faces are there on a cube? *Six.*

2. Will any six connected square faces fold to make a cube? ***No.*** Why or why not? ***Answers vary.***

CONCLUSIONS:

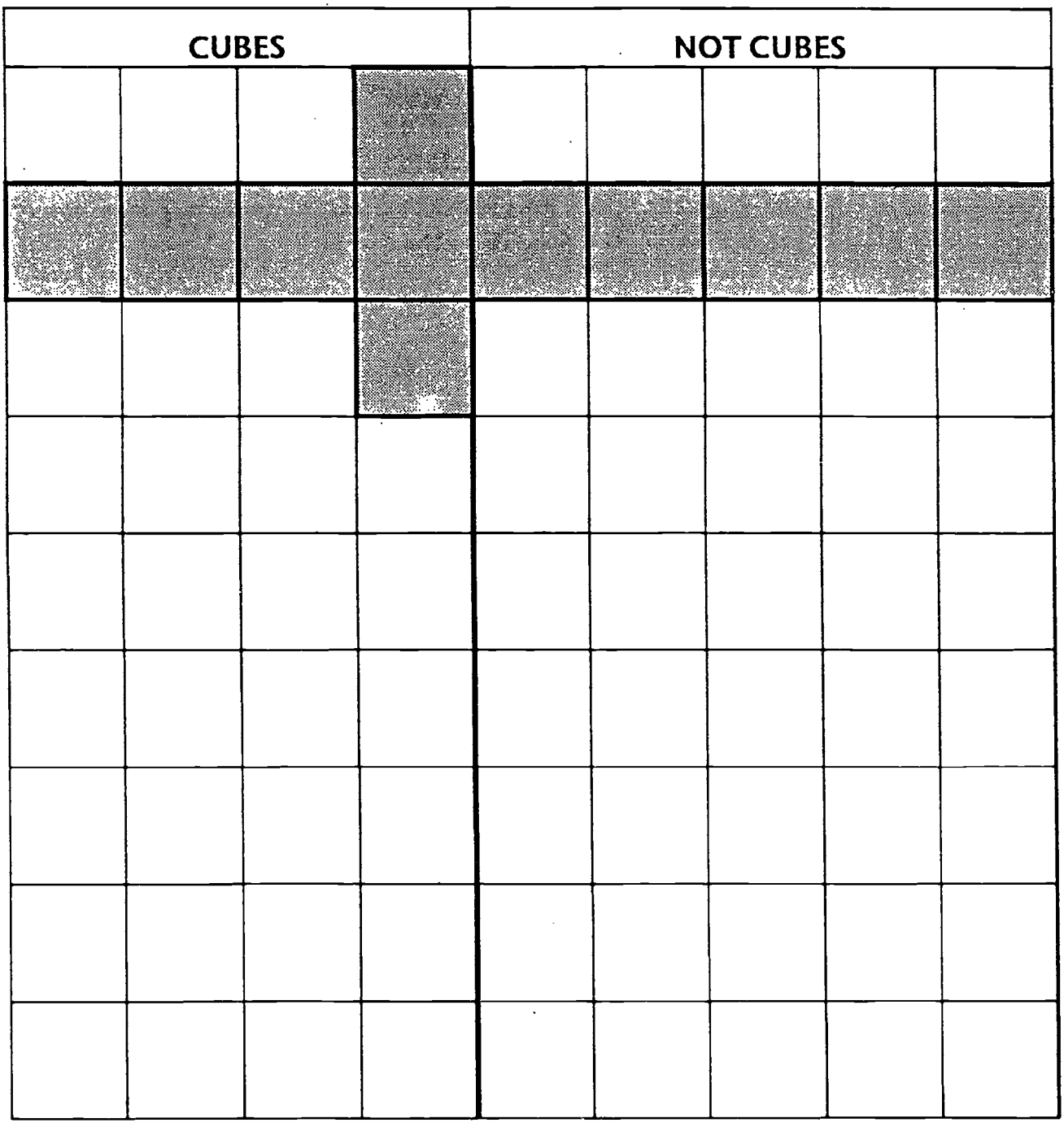
1. What rule can you make that can be used to help you decide if a six square pattern can be folded to become a cube? ***Answers vary. Possible answer may be that some squares must be connected.***

2. Why must the pattern for a cube have squares in two directions, both up and down (horizontal and vertical)? ***Answers vary. Possible answer may be because a cube has a top, bottom, and sides, and they go up and down.***

SUGGESTIONS FOR FURTHER STUDY:

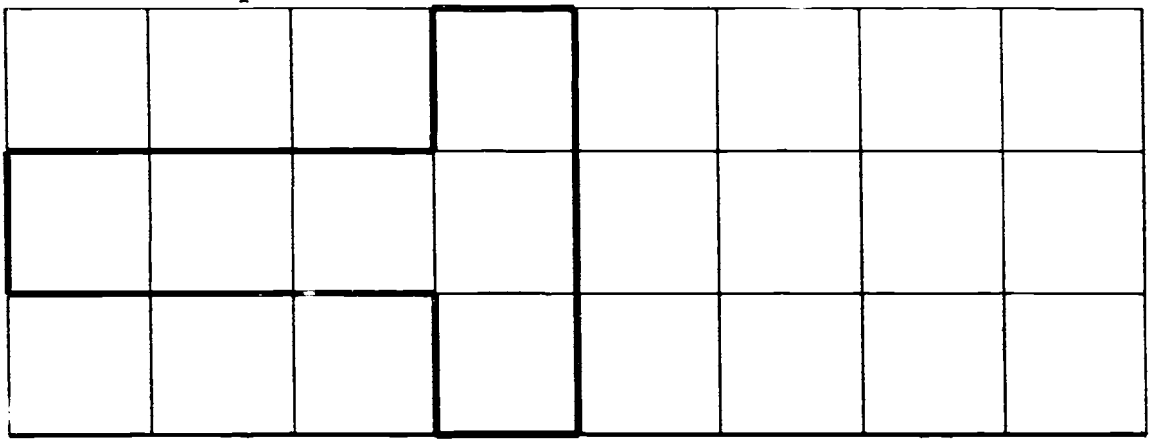
- Use wooden blocks or cardboard building blocks to build larger cubes. Once you construct the cubes, make a drawing of the construction you made on poster paper. Share your drawing with your class.
- Make a cube. Use straws and pipe cleaners to make squares. Use pipe cleaners to connect the squares together to make a cube. Hang the cube from the ceiling using yarn or string.

Response Sheet
Creating Cubes From Squares

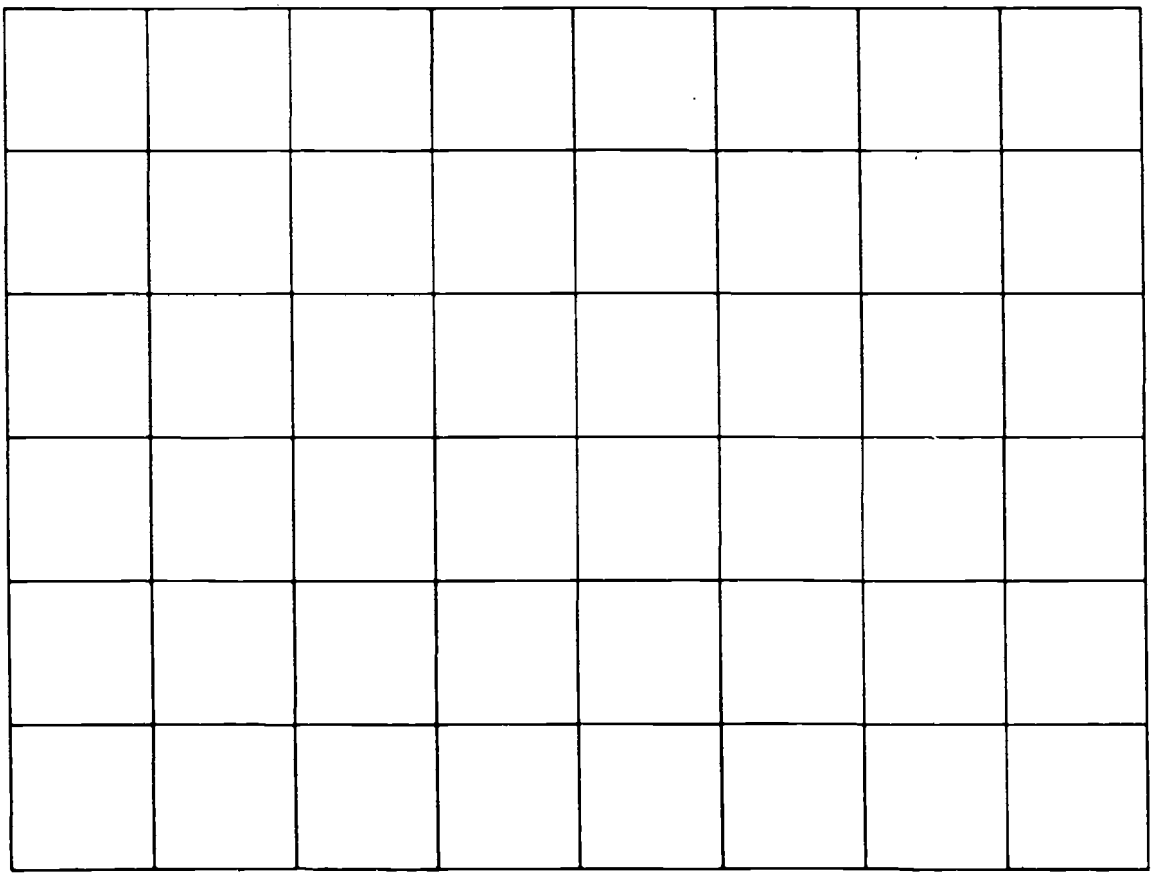


Creating Cubes From Squares

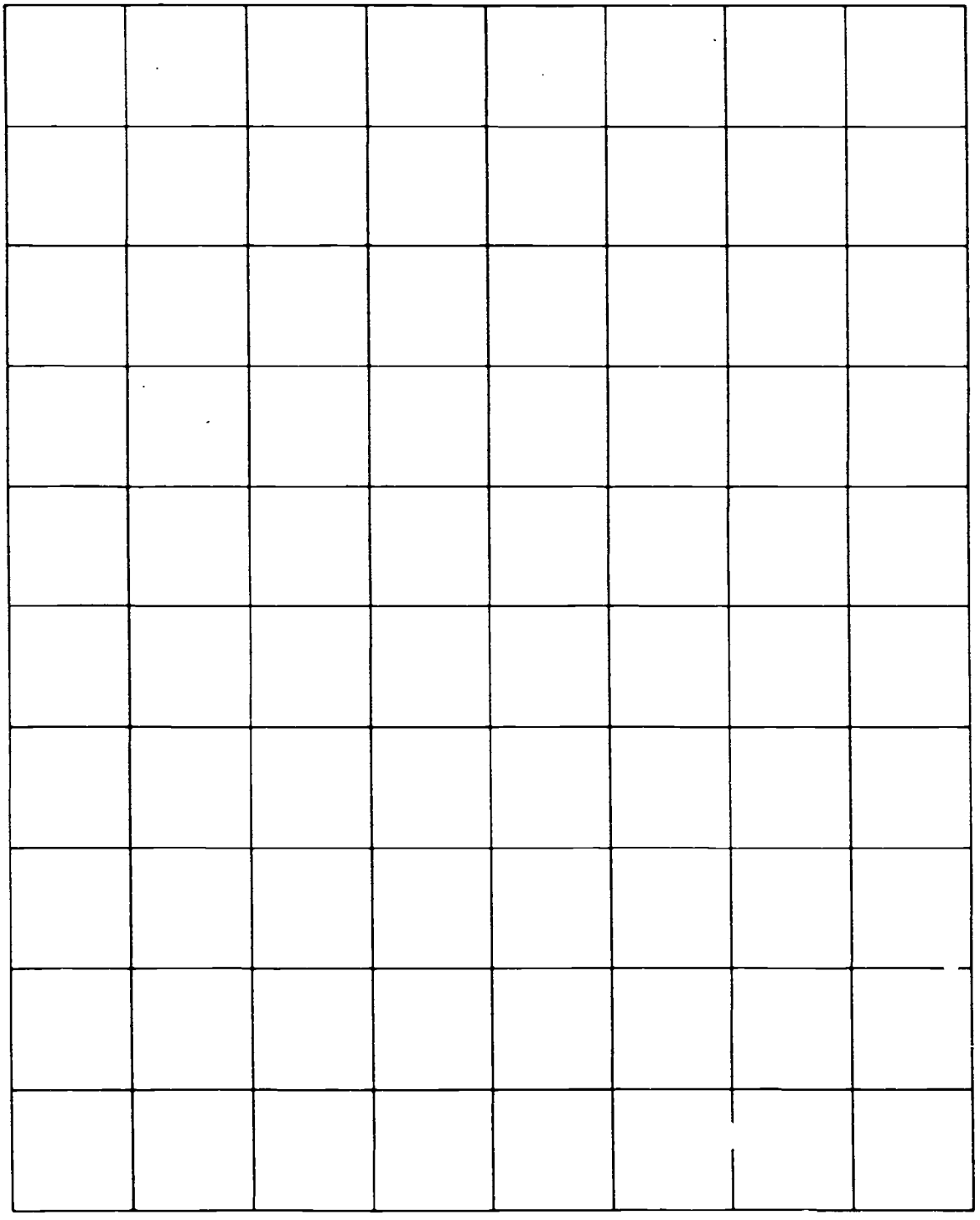
1. Cut out the pattern. Fold to make a cube.



2. On the grid paper, outline four other patterns of six squares that you think will make a cube. Cut out the squares, fold and tape them together. Make a drawing of your pattern on the Response Sheet and indicate whether or not it can be folded into a cube.



More Grid Paper



Teacher's Guide
The Shape of Things To Come

GOAL: To have students explore making two-dimensional patterns that can be folded to form polyhedra.

STUDENT OBJECTIVES:

- ✓ To construct two-dimensional patterns.
- ✓ To create two-dimensional patterns that can be folded to form a polyhedron.

GUIDE TO THE INVESTIGATION: Discuss and show models of polyhedra, including cubes, pentagonal pyramids, hexagonal prisms, and tetrahedrons. Discuss the number of faces for each.

This activity can be carried out by individual students with the guidance of an adult. Younger students will need help in gluing the cubes together, painting them, and taking them apart without breaking them.

Students need scissors, glue, grid paper, ruler, and a protractor.

Have students follow the directions in the Procedures section.

1. Trace and make a copy of the figure provided.
2. Cut the figure, fold along the dotted line, and glue the flaps in place.
3. Select another polyhedron. Use it as a model to make a pattern.
4. Use a ruler, protractor, or other measuring instrument to create a pattern for the selected polyhedron. Decide where you will need to make fold lines and where you will place the flaps.
5. Cut out your pattern, fold it, and glue it together.

Discuss the Observations and Conclusions.

VOCABULARY: two-dimensional, polyhedron, pentagonal pyramid, hexagonal prism, faces, tetrahedron, polyhedra

The Shape of Things To Come

INTRODUCTION: Polyhedrons can be constructed from two-dimensional patterns. In this activity you will create a two-dimensional pattern and fold it so it becomes a polyhedron.

PURPOSE:

- ✓ What is a polyhedron?
- ✓ What two-dimensional patterns can be folded to form a polyhedron?

MATERIALS:

scissors
glue
grid paper
ruler
protractor

PROCEDURES:

1. Trace or make a copy of the figure provided on the Response Sheet.
2. Cut out the figure, fold along the dotted lines, and glue the flaps in place. What kind of polyhedron did the folded pattern create?
   Triangular.
3. Next, select another polyhedron - a cube, a pentagonal pyramid, or a hexagonal prism.
4. Use the polyhedron as a model for making a pattern. Look carefully at the model and imagine how it would look if it had been cut apart and laid flat on a plane.
5. Once you have a mental picture of the pattern, use a ruler, protractor or other measuring instrument to create a pattern for the polyhedron, with accurate dimensions. Determine where you will need to make fold lines, where you will place the flaps, etc..
6. Cut out your pattern, fold it, and glue it together.

OBSERVATIONS:

1. Does the polyhedron you created have the correct number of faces? How do you know? ***Answers vary.***
2. Do all of the faces fit together snugly? ***Answers vary.***
3. Does your polyhedron resemble the model? ***Answers vary.***

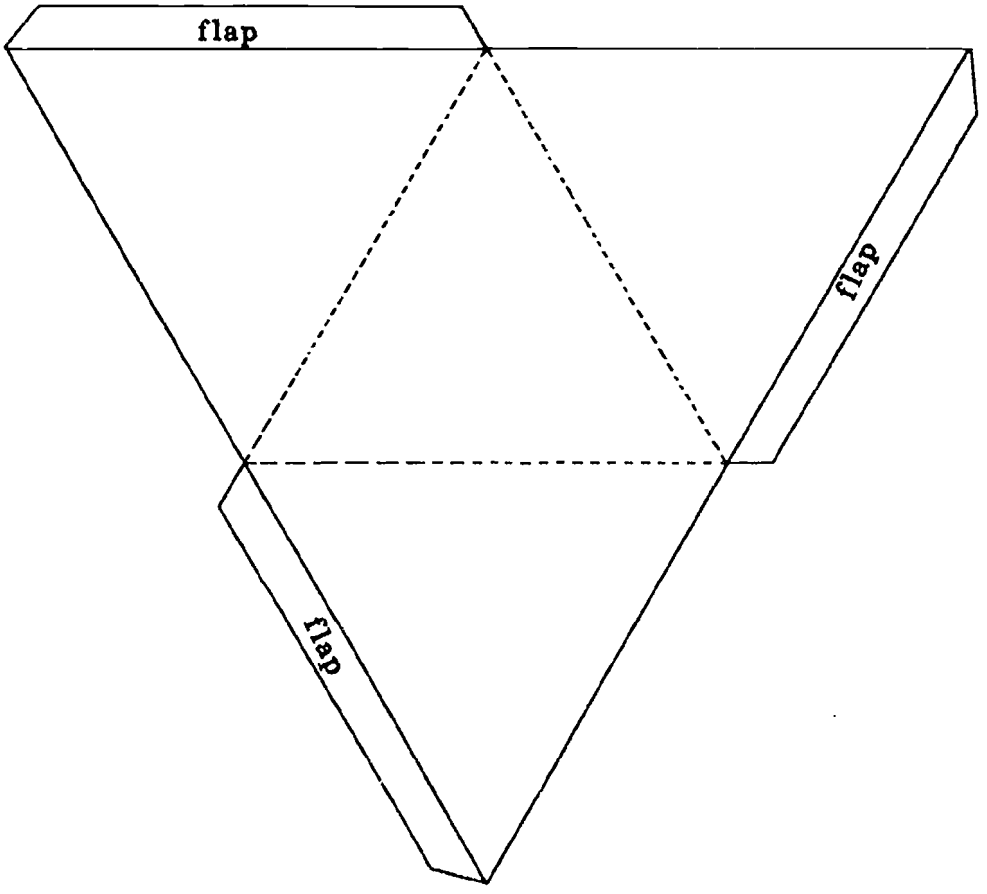
CONCLUSIONS:

1. Is it easier to make a tetrahedron from a model or a model from a tetrahedron? Why do you think so? ***Answers vary.***
2. What steps would you use when making a drawing of a tetrahedron and model for cutting and folding the tetrahedron? ***Answers vary.***
   Possible answers may be: count the number of sides; mentally picture how the sides fit together; make a sketch, etc.

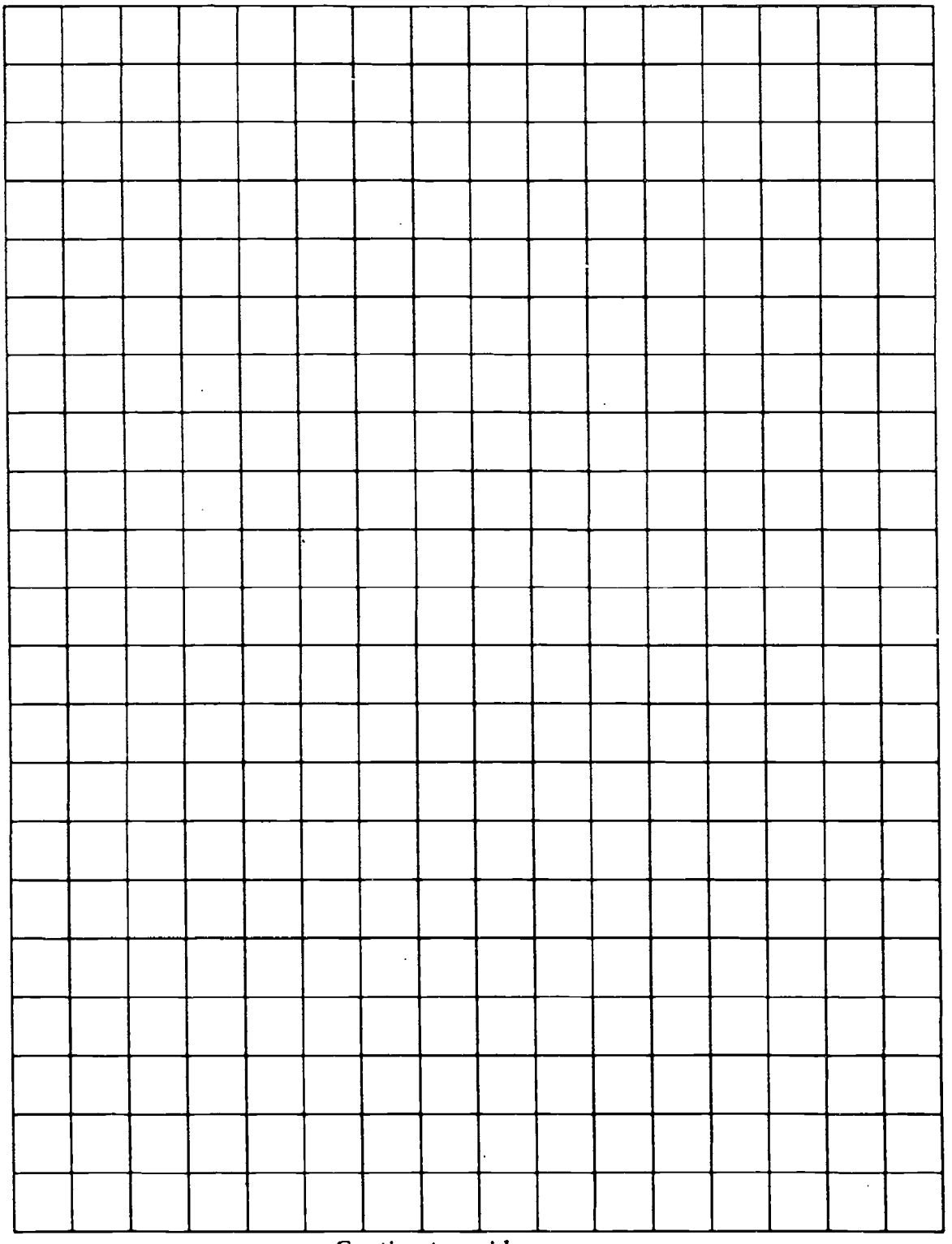
SUGGESTIONS FOR FURTHER STUDY:

- Create several different patterns for a cube. Draw, cut out, fold, and tape the cubes. Make a mobile using the cubes.
- Use straws and pipe cleaners to construct polyhedra. Make many two-dimensional figures. Use pipe cleaners to connect the two-dimensional figures to make three-dimensional polyhedra. Make a chart to show the number of faces, edges, and vertices each three-dimensional figure has. Share your constructions and chart with your class. Did you get the same number of faces, edges, and vertices for the same figures? If not, how were mistakes made? ***Answers vary. Constructions were different figures.***

Response Sheet
The Shape of Things To Come



Response Sheet



Centimeter grid paper

Teacher's Guide
Toothpick Squares

GOAL: To have students explore shapes and how they are formed and to look for number patterns while constructing squares.

STUDENT OBJECTIVES:

- ✓ To construct squares using toothpicks.
- ✓ To find number patterns while constructing squares.

GUIDE TO THE INVESTIGATIONS: Discuss polygons - triangles, squares, and rectangles. Discuss the number of sides for each and whether the sides are the same length. Have students describe characteristics of a square.

Students need a minimum of 100 toothpicks each and a pencil or marker for this activity.

This activity can be carried out by individual students under the guidance of an adult. Older students may complete the activity on their own.

Have students follow the directions in the Procedures section.

1. Make a square using four toothpicks. Draw the square on the Response Sheet.
2. Use the toothpicks to make the design shown.
3. Use the number of toothpicks shown on the chart to make squares.
4. Complete the chart by writing the number of small squares and large squares.

Discuss the Observations and Conclusions.

VOCABULARY: patterns

Toothpick Squares

INTRODUCTION: In many branches of mathematics you will find patterns. In this activity you will use toothpicks to make squares. You will make squares using an even number of toothpicks and will discover patterns that result from various numbers of squares.

PURPOSE:

- ✓ How many toothpicks are needed to make one square?
- ✓ How many squares can be made with 12 toothpicks? With 20 toothpicks?

MATERIALS:

toothpicks
pencil or marker

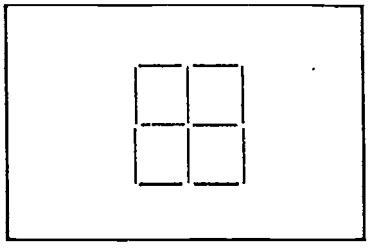
PROCEDURES:

1. Make a square using four toothpicks. Draw the square on the Response Sheet.
2. Use toothpicks to make the design shown.

   How many toothpicks did you use ?

   How many small squares did you make ?

   How many squares did you make in all ?



10 - 1

3. Use the number of toothpicks shown on the chart to make squares.
4. Complete the chart by writing the number of small squares and large squares. What patterns did you make?
5. Which numbers of toothpicks can be used to make a large square from small squares?

OBSERVATIONS:

1. How many toothpicks were used to make one square? *4*
2. How many squares were made from 12 toothpicks? *4*
   From 20 toothpicks? *7*

CONCLUSIONS:

1. What pattern did you discover when the small squares were made into a large square? ***Answers vary. Possible answer may be that a square "built onto" another may take only two or three toothpicks, rather than four.***
2. What pattern did you find that lets you predict the number of toothpicks needed to make larger squares? ***Answers vary.***
3. What did you discover when you used odd numbers of toothpicks (7,17)? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

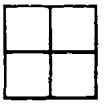
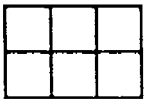
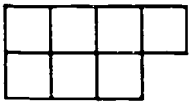
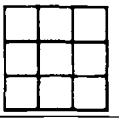
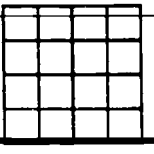
- Use toothpicks to make triangles. What is the least number of toothpicks that can be used to make a triangle? *3.*
  How many triangles can be made using five toothpicks? *2.*
  Are all sides the same length? *Yes*
- Draw a picture of the triangles you made using five toothpicks. Draw a picture of the triangles you made using seven toothpicks and nine toothpicks. What is the least number of toothpicks that can be used to make a large triangle with three small triangles on the "inside"? *6.*
  How many triangles, with the same length sides, can be made using eighteen toothpicks? *9.*
  Make a drawing or poster of your toothpick triangles to share with your class.

Response Sheet
Toothpick Squares

1. Draw a picture of a square made from four toothpicks.

2. How many toothpicks did you use to make the design illustrated? *12*
   How many small squares did you make? *4*
   How many squares in all? *5*

3. Complete the chart. Look for patterns. Make a drawing of the arrangement.

No. of toothpicks	No. of small squares	Total number of squares	Drawing
4	1	1	
7	2	2	
12	4	5	
17	*6*	*6 or 8*	
20	*7*	*7 or 9*	
24	*9*	*10 or 14*	
40	*16*	*17 or 26*	

Teacher's Guide
Constructing Three-Dimensional Models

GOAL: To have students explore the properties of three-dimensional figures through the construction and investigation of the figures.

STUDENT OBJECTIVES:

- ✓ To construct three-dimensional figures.
- ✓ To count faces, vertices and edges of the three-dimensional figures.

GUIDE TO THE INVESTIGATION: Discuss plane and solid figures with students. Have them draw two-dimensional shapes. Display and discuss three-dimensional shapes such as a cube. Introduce face, edge, and vertices.

Students need toothpicks, gumdrops, or miniature marshmallows, pencil, and paper for this exploration.

This activity can be carried out by individual students under the guidance of an adult. Older students can work together in small groups to complete this exploration.

Direct students to follow these directions:

1. Build three-dimensional figures by sticking toothpicks into gumdrops or marshmallows.
2. Follow the picture directions in the Procedure section.
3. Count and record on the Response Sheet the number of faces, vertices, and edges.

Discuss the Observations and Conclusions.

VOCABULARY: three-dimensional, face, vertices, edge

Constructing Three-Dimensional Models

INTRODUCTION: A cube is a three-dimensional figure. It has corners called vertices. It has edges that connect the corners and faces or sides. Not all three-dimensional figures have edges or vertices. A sphere is a three-dimensional figure with no edges or vertices. In this activity you are going to build three-dimensional figures that have faces, vertices, and edges.

PURPOSE:

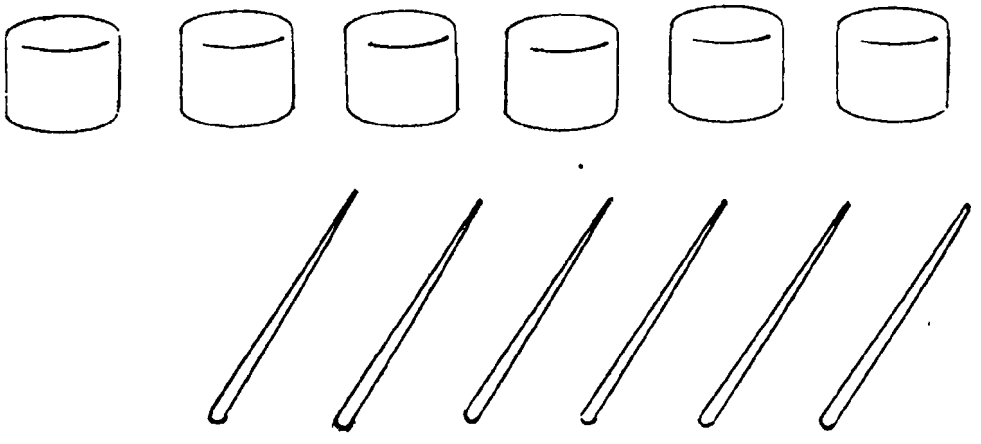
- ✓ What is a three-dimensional figure?
- ✓ What are faces, vertices, and edges?
- ✓ Do all three-dimensional shapes have faces, vertices, and edges?

MATERIALS:

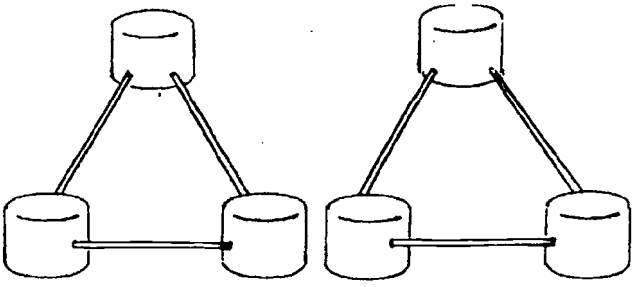
toothpicks
gumdrops or
miniature marshmallows
pencil
paper

PROCEDURES:

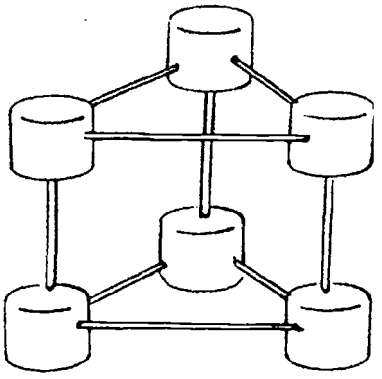
1. Build three-dimensional figures by sticking the toothpicks into the marshmallows. Start with: six marshmallows and six toothpicks



2. Make:

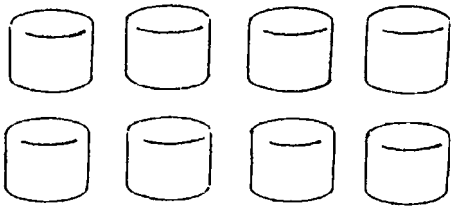


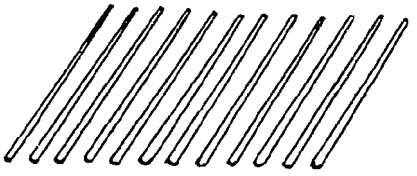
3. Now connect the figures with three more toothpicks to look like:



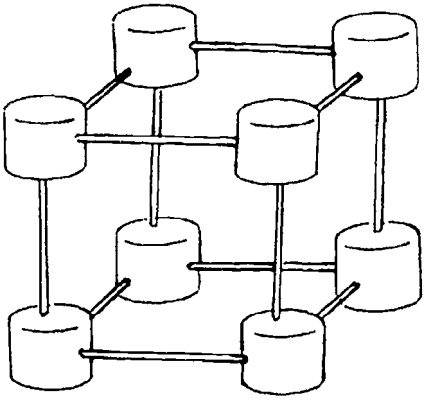
4. Pretend that the figure has flat surfaces. Count them. There are five flat surfaces.

5. Use



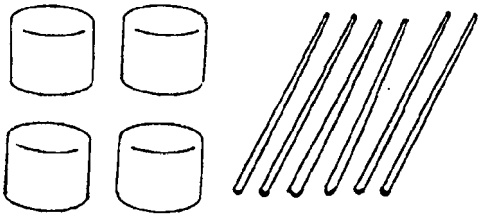


to make:

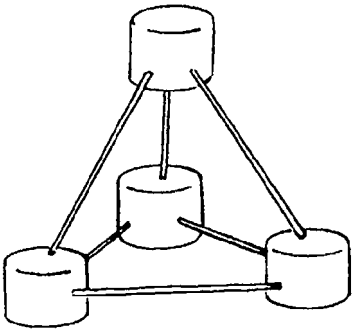


6. Record on the Response Sheet how many faces, vertices, and edges the figure has.

7. Now use



and make



8. Count and record the faces, vertices, and edges and record the numbers on the Response Sheet.

9. Make other constructions with toothpicks and marshmallows or gumdrops. Guess how many faces, vertices, and edges each one will have. Count the faces, vertices, and edges. Record your results in the chart shown on the Response Sheet.

OBSERVATIONS:

1. Do all three-dimensional models have faces? Which ones that you made have faces? ***Yes. Answers vary.***

2. Do all three-dimensional models have vertices? Which ones that you made have vertices? ***No. Answers vary.***

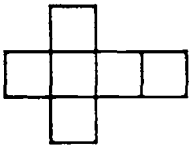
3. Do all three-dimensional models have edges? Which ones that you made have edges? ***No. Answers vary.***

CONCLUSIONS:

1. Why is it difficult to visualize three-dimensional shapes in drawings? ***Answers vary.***
2. How can constructing three-dimensional shapes from gumdrops and toothpicks help you gain a better understanding of three-dimensional shapes, faces, vertices, and edges? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

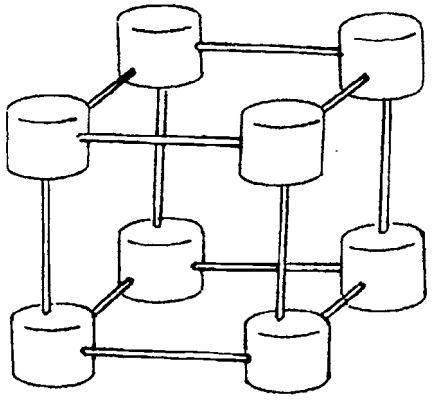
- Use modeling clay to make three-dimensional shapes. Make cubes, cones, prisms, and cylinders. Use a piece of "piano wire" (a wire with a handle an each end) to slice through the clay model. Predict what the face of the slice will be for each of the shapes made. Can you slice a cube so the slice becomes another three-dimensional solid? ***Answers vary.***
- Cut shapes from grid paper that can be taped together to make models of three-dimensional figures. For example:



can be folded and taped to become a

Response Sheet
Constructing Three-Dimensional Models

1.

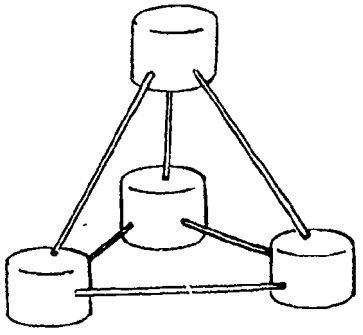


_6_ faces

_8_ vertices

_12_ edges

2.



_4_ faces

_4_ vertices

_6_ edges

3.

SKETCH	FACES	VERTICES	EDGES
Pictures and answers vary.			

Teacher's Guide
Symmetrical Logos

GOAL: To have students explore symmetry in designs.

STUDENT OBJECTIVES:

- ✓ To identify symmetry in designs and logos.
- ✓ To design a logo with a symmetrical design.

GUIDE TO THE INVESTIGATION: Demonstrate how to cut a heart from folded paper. Have students cut a simple design from folded paper. Discuss how each side of the design is symmetrical.

Students need magazines, newspapers, construction paper, scissors, pencils, crayons or markers, and glue or paste to complete this activity.

This activity can be carried out by individual students or by pairs or small groups. Some adult guidance is necessary for younger students.

Have students follow these directions:

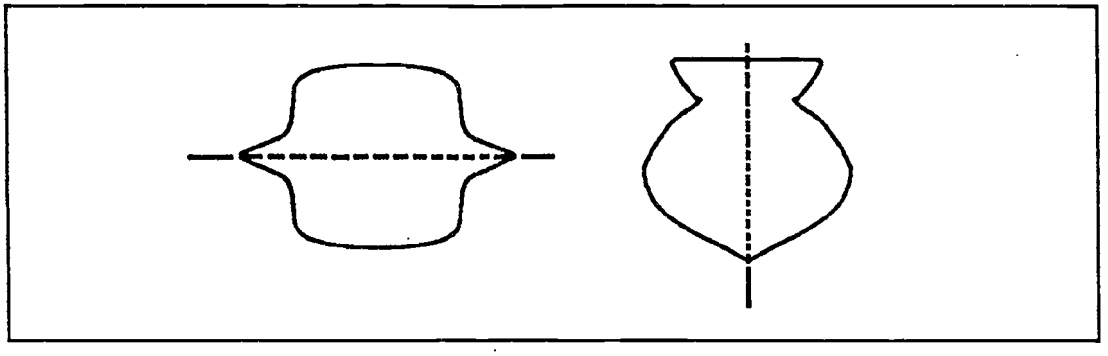
1. Look in magazines or newspapers. Find five to ten designs or logos that have outlines.
2. Cut out the designs.
3. Fold the designs into halves. Look at the halves. Decide if the two halves are symmetrical.
4. Glue or paste several of the designs on the Response Sheet. Use a crayon or marker to mark the line where you folded the design.
5. Fold a sheet of construction paper. Cut through both layers to make a symmetrical design.
6. Unfold the design. Use the design you cut to make a symmetrical logo by writing your name on the design.
7. Make a drawing on the Response Sheet of the logo you created.

When students complete the activity, discuss the Observations and Conclusions.

VOCABULARY: symmetrical, logos, imaginary

Symmetrical Logos

INTRODUCTION: Some designs are symmetrical. They are the same size and shape on both sides of an imaginary line. In this activity you will find logos or designs that have lines of symmetry and will design your own symmetrical logos.



12 - 1

PURPOSE:

- ✓ What is symmetry?
- ✓ How can you decide if a design is symmetrical?
- ✓ How can a symmetrical design be created?

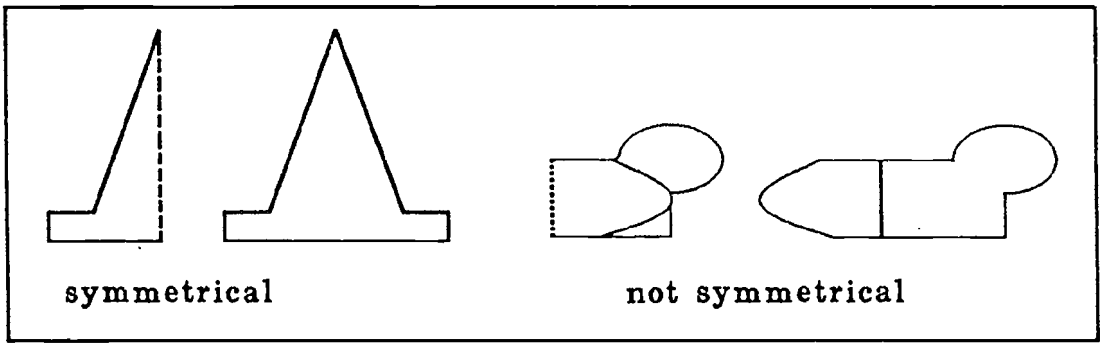
MATERIALS:

magazines or newspapers
construction paper
pencils
crayons or markers
scissors
glue or paste

PROCEDURES:

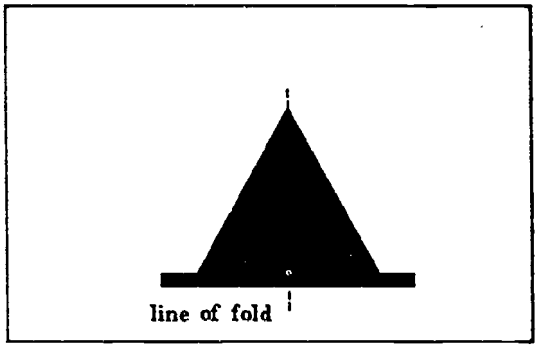
1. Look in magazines or newspapers. Find five to ten designs or logos that you think have lines of symmetry.
2. Carefully cut out the designs or logos.

3. Fold the designs into halves. Look at the two halves. Decide if the design is symmetrical or not.



12 - 2

4. Glue or paste several of the designs on the Response Sheet. Use a crayon or marker to mark the line where you folded the design.
5. Fold a sheet of construction paper. Cut through both layers to make a symmetrical design.



12 - 3

6. Unfold the design. Use the design you cut to make a symmetrical logo by writing your name on the design.
7. Make a drawing on the Response Sheet of the logo you created.

OBSERVATIONS:

1. Which designs or logos that you found in the magazine or newspaper were symmetrical? ***Answers vary.***
2. How do you know the designs were symmetrical? ***When one side is folded over the other, they are the same size and shape.***

CONCLUSIONS:

1. How can you describe designs or logos that are symmetrical? ***Both sides are identical.***

2. Why are some designs or logos not symmetrical? ***You cannot make a line of symmetry with both sides identical.***

SUGGESTIONS FOR FURTHER STUDY:

- Make a logo using sturdy cloth and permanent markers. Sew the logo onto a tee shirt, a jacket, or some jeans.
- Schools, colleges, professional athletic teams, and businesses have logos. Get a copy of your favorite logo — school, college, or professional team. Decide if the logo is symmetrical. Research by reading or interviewing someone who knows why this logo was chosen for the school or team. Write a few sentences about the logo and what it stands for or means. Share your findings with your class.

Response Sheet
Symmetrical Logos

Glue several designs or logos here. Mark the "fold" line with a crayon or marker.

Designs vary.

Make a drawing of the logo you made with your name.

Drawings vary.

MEASUREMENT

Teacher's Guide
Making A Sand Timer

GOAL: To develop with students an understanding of various devices for measuring time and the need for a standard measure of time.

STUDENT OBJECTIVES:

- ✓ To explore various ways of measuring time.
- ✓ To make a sand timer.
- ✓ To measure time using a sand timer.
- ✓ To become aware of a need for a standard measure of time.

GUIDE TO THE INVESTIGATION: Students need a paper or Styrofoam cup, a tack or a small nail, a pint or quart jar, and sand, salt or cornmeal, a ball, and a jump rope for this investigation.

This activity can be completed by individual students with the guidance of an adult or older students can work together in small groups to make the sand timer and complete the experiments.

Have students follow these directions:

1. Make a hole in the bottom of the cup with the tack or nail.
2. Turn the cup over.
3. Hold a finger under the hole made with the tack. Fill the cup with sand, salt, or cornmeal.
4. Place the hole in the bottom of the cup over the mouth of the jar.
5. Have an adult or student count while another student bounces a ball or jumps rope. The person who is counting should begin when the finger is released from the hole in the cup. Discuss the results.

Discuss the Observations and Conclusions.

VOCABULARY: time, measure, sand timer, standard

Making A Sand Timer

INTRODUCTION: Do you have a watch? Does it have numbers on the face? Are there hands on the watch? A clock with hands is an analog clock. A digital clock has numbers that "change" without hands moving around. There are other ways of measuring time. An hour glass was used long ago to measure time. In this activity you will make a sand timer that works like an hour glass and you will use the sand timer to find how long some activities take.

PURPOSE:

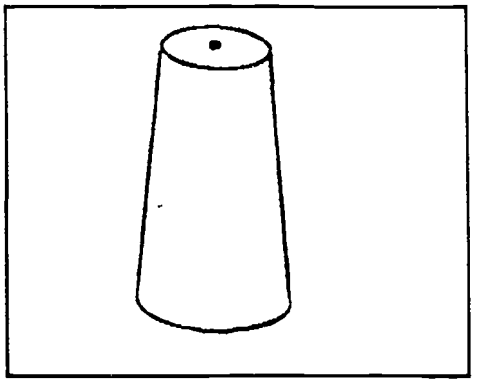
- ✓ What are some ways of measuring time without using clocks and watches?
- ✓ How can a sand timer be made?
- ✓ How many times can you bounce a ball or jump rope before the sand runs from the timer?
- ✓ What difference does the size of the hole in the sand timer make?
- ✓ Is a sand timer a practical way to measure time?

MATERIALS:

paper cup or Styrofoam cup
tack or small nail
pint or quart jar
sand, salt, or cornmeal
rubber ball
jump rope

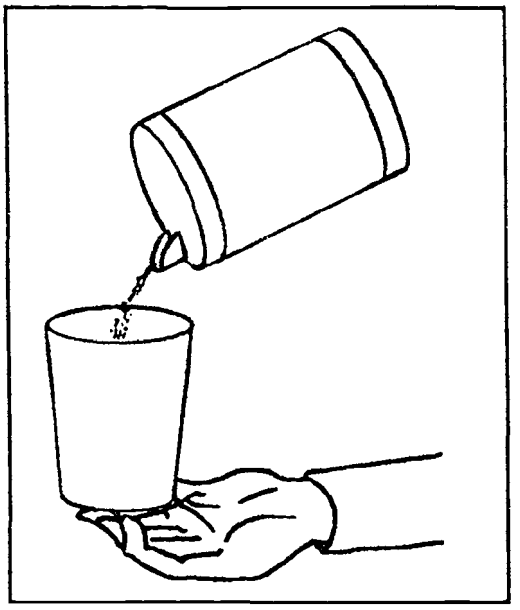
PROCEDURES:

1. Make a hole in the bottom of the cup.
2. Turn the cup over. Hold your finger over the hole. Fill the cup with sand, salt, or cornmeal. (See illustration 13-2.)



13 - 1

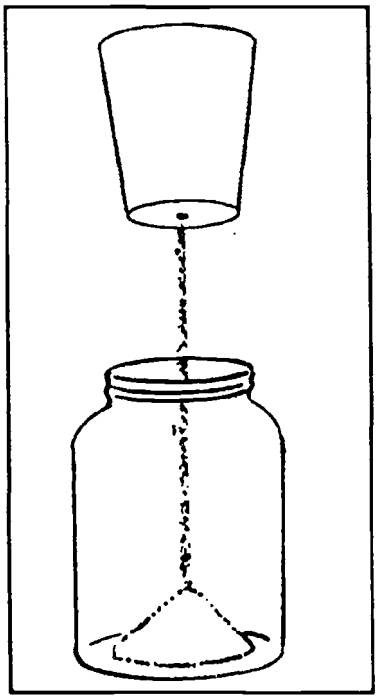
3. Place the hole in the bottom of the cup over the mouth of the jar and remove your finger.
4. Have your teacher or another student count the number of times you can bounce a ball before all the sand runs into the jar. The counter should start counting your bounces when they remove their finger from the hole. Repeat the activity and see how many times you can jump rope. Repeat again with you handling the timer and another student bouncing the ball and jumping rope.



13 - 2 *Put your finger over the hole in the cup while you pour.*

OBSERVATIONS:

1. Compare the number of times you bounced the ball before the sand dripped out of the cup with the number of times a friend bounced the ball before the sand dripped out. Who bounced the ball more times before the sand ran out? ***Answers vary.***
2. Why did you and the friend bounce the ball a different number of times? ***Answers vary.***
   Possible answers may be one bounces faster or the sand ran faster or slower.
3. How many times did you jump the rope before the sand ran into the jar? ***Answers vary.***
4. Compare the number of jumps for you and a friend. Why are the numbers different?
   Answers vary. Possible answers may include the speed of jumping or the time it took the sand to run out of the cup.



13 - 3

CONCLUSIONS:

1. If you made the hole in the cup of the timer larger, would the sand take more time or less time to run out of the cup? Why? ***Less, because it would run out faster.***

2. With a larger hole in the cup, would you have been able to bounce the ball more times or fewer times? ***Fewer.***

3. What are some advantages and disadvantages of a sand timer?
   Answers vary. Possible answers may be: Advantages– it is easy to make; Disadvantages– it is not accurate.

SUGGESTIONS FOR FURTHER STUDY:

- Make a water timer using an empty juice can. Make a hole in the can with a tack or a nail. Fill the timer with water while holding your finger over the hole. Have someone help you compare the time it takes the water to drip into a jar and the time it takes the sand to drip into a jar.

Response Sheet
Making A Sand Timer

Number of times:

1. I bounced the ball using the sand timer. ***All answers will vary.***

2. My friend bounced the ball using the sand timer._____

3. I jumped the rope using the sand timer._____

4. My friend jumped the rope using the sand timer._____

5. I bounced the ball using the sand timer with a larger hole in the cup._____

6. I jumped the rope using the sand timer with a larger hole in the cup._____

Teacher's Guide
Measure With Me

GOAL: To have students explore using measures of body parts as standards for measuring lengths and distances.

STUDENT OBJECTIVES:

- ✓ To use widths and lengths of body measures to measure longer lengths and distances.

GUIDE TO THE INVESTIGATION: Ask students if any of them have ever seen someone measure fabric (cloth) by placing one end of the fabric at the nose and stretching the cloth to the end of the arm. Explain that before people had measuring instruments they used body measures to measure lengths and distances.

Students need a pencil and the Response Sheet for this activity.

Students can explore this activity individually, but the fathoms (reaches) and cubits are better measured if students work in pairs. Demonstrate and discuss each of the body measures with the whole class.

Have students estimate lengths and distances and then use body measurements to check their estimates. Students should guess (estimate) the number of each body measure and record the number on the Response Sheet. Then with a partner, each should use the body measures and actually measure the length and width of the classroom. Estimates and measures should be recorded on the Response Sheet.

Have students follow the directions in the Procedures section.

1. Stand with a partner. Each of you walk forward using baby steps.
2. You and your partner compare hand spans.
3. Compare palm widths with your partner.
4. Bend your arm to find a cubit.
5. Walk a pace according to directions on the student page.
6. Stretch your arms to reach a fathom.
7. Estimate the number of some different body measurements it takes to measure the width of your classroom. Record the estimates. Then measure the width of the room with body measures and compare actual measures with estimates.

After students complete their measuring, discuss the Observation and Conclusion questions.

VOCABULARY: palm, span, cubit, fathoms, paces

Measure With Me

INTRODUCTION: When you do not have a standard measuring tool, you can use your own body measurements to measure lengths or distances. In this activity you will measure lengths and distances using measurements of your palms, spans, cubits, fathoms, and paces.

PURPOSE:

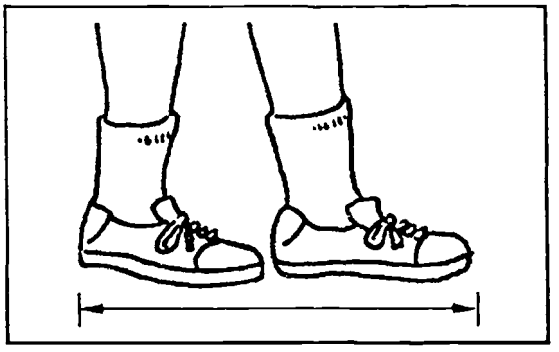
- ✓ What body measures can be used to measure lengths?
- ✓ What body measures can be used to measure longer distances?

MATERIALS:

paper
pencil

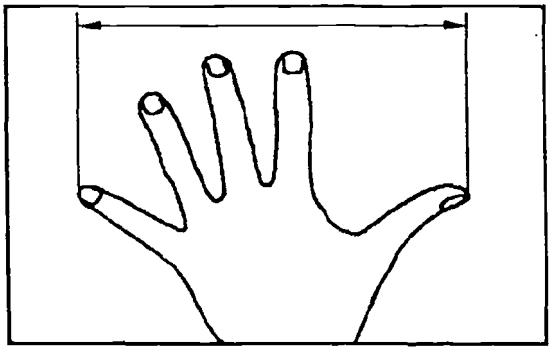
PROCEDURES:

1. Stand beside a partner. Each of you walk forward using baby steps. A baby step is made by placing the heel of one foot in front of (touching) the toe of the other foot as shown in the illustration 14-1.



14 - 1 *Baby steps*

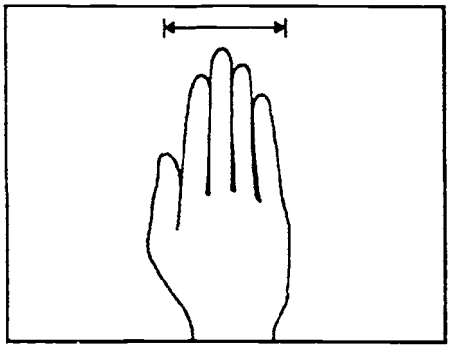
2. Next you and a partner compare your handspans as shown in illustration 14-2.



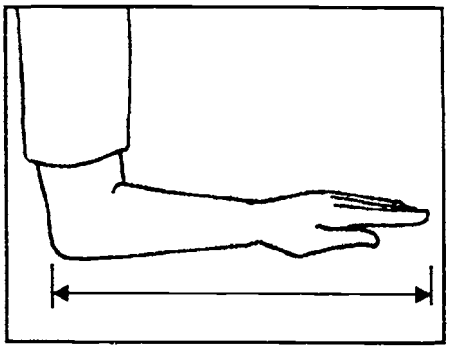
14 - 2 *Hand spans*

3. Compare your palm width with your partner as shown in the illustration 14-3.

4. Bend your arm as shown in the illustration 14-4. The length from elbow to fingertips is called a cubit.



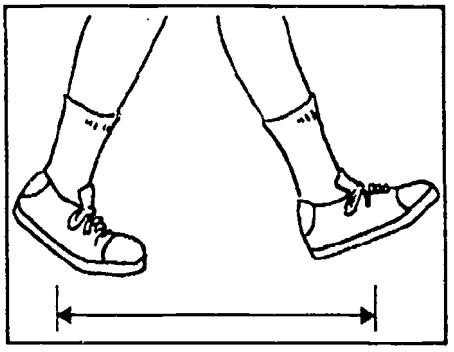
14 - 3 *Palm width*



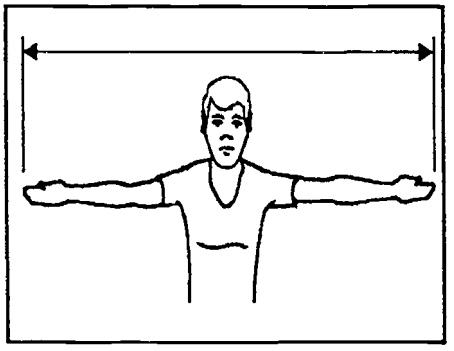
14 - 4 *Cubits*

5. You and your partner should walk in paces as shown in the illustration 14-5.

6. Your reach, with your arms stretched out as shown in the illustration 14-6, is called a fathom.



14 - 5 *Paces*



14 - 6 *Reaches (fathoms)*

7. Once you and your partner have identified each of the body measures, estimate how many of each measure it would take to measure across your classroom. Then actually measure across the classroom using the body measures. Record your estimates and actual body measures on the Response Sheet.

OBSERVATIONS:

1. What body measures can be used to measure lengths or distances? ***Hands, arms, legs, feet, etc.***
2. Did you and your partner get the same measure using your body measures? Why or why not? ***Answers vary. Probably not, because lengths of arms, feet vary.***
3. Did your estimates become more accurate the more times you estimated and measured? ***Probably yes.***

CONCLUSIONS:

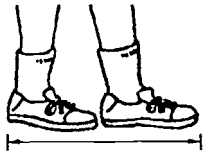
1. Why is measuring with body measures not the best way to measure lengths or distances? ***Each person's hand, foot, etc. are different sizes or lengths.***
2. Why do different people get different measurements when using body parts as standards of measure? ***Body parts are not the same size.***
3. What measuring units will insure that you will get an accurate measurement? ***A standard unit such as inches, feet, centimeters, etc.***

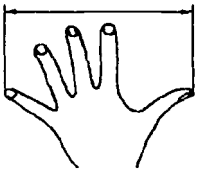
SUGGESTIONS FOR FURTHER STUDY:

- Compare body measures to standard measures. How many palms make a foot? How many baby steps make a yard? How many inches make a reach? Compare your answers with a partner. Why are they alike or different? ***Answers vary. Different people have different sized arms, feet, etc.***
- Measure and record the length, width or distance of objects and rooms in your home using the handspan, pace, and other body measures. Make a poster or chart that shows the measures you made.
- Try to find a book about the history of measurement in your library. Read the book or ask your teacher to read the book to your class. Discuss interesting facts you learned from the book.

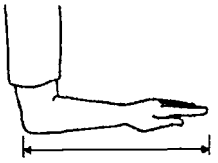
Response Sheet
Measure With Me

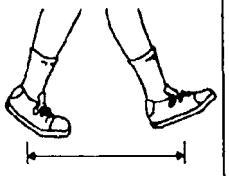
How far is it across your classroom? Estimate and write the number of baby steps, hand spans, palms, cubits, paces, and fathoms on the chart. Then use the body measures to actually measure the length or width of your classroom.

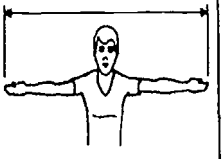
Baby Steps	Estimate	Actual
		

Span	Estimate	Actual
		

Palm	Estimate	Actual
		

Cubit	Estimate	Actual
		

Pace	Estimate	Actual
		

Reach	Estimate	Actual
		

Teacher's Guide
Georimeter

GOAL: To have students make a geoboard and investigate the perimeter of various polygons on the geoboard.

STUDENT OBJECTIVES:

- ✓ To make a geoboard.
- ✓ To find the perimeter of various polygons formed on the geoboard.

GUIDE TO THE INVESTIGATION: Discuss polygons and perimeter with students. Have students describe and give examples of polygons.

Students need a 6 inch by 6 inch wood square, 25 small nails or tacks, a hammer, a ruler, rubber bands, and a crayon or pencil. (If students made a geoboard in Activity 5, the *What's My Area?* investigation, they can use it for this one.)

This activity can be completed by individual students with the guidance of an adult to make the geoboard. The adult should assist the student in placing the nails or tacks on the wood square as shown in the Procedures section.

Have students follow these directions:

1. Use rubber bands to make designs and words on the geoboard.
2. Use rubber bands to make the figures shown in the Procedures section.
3. Count the number of segments around each figure to find its perimeter.

Discuss the Observations and Conclusions.

VOCABULARY: geoboard, perimeter, polygons

Georimeter

INTRODUCTION: A geoboard has nails, tacks, or pegs that are an equal distance apart. Rubber bands can be used on the nails to make figures and designs. In this activity you will make a geoboard and make designs on the board. You will count the segments or inches around the figures to find the perimeter of each.

PURPOSE:

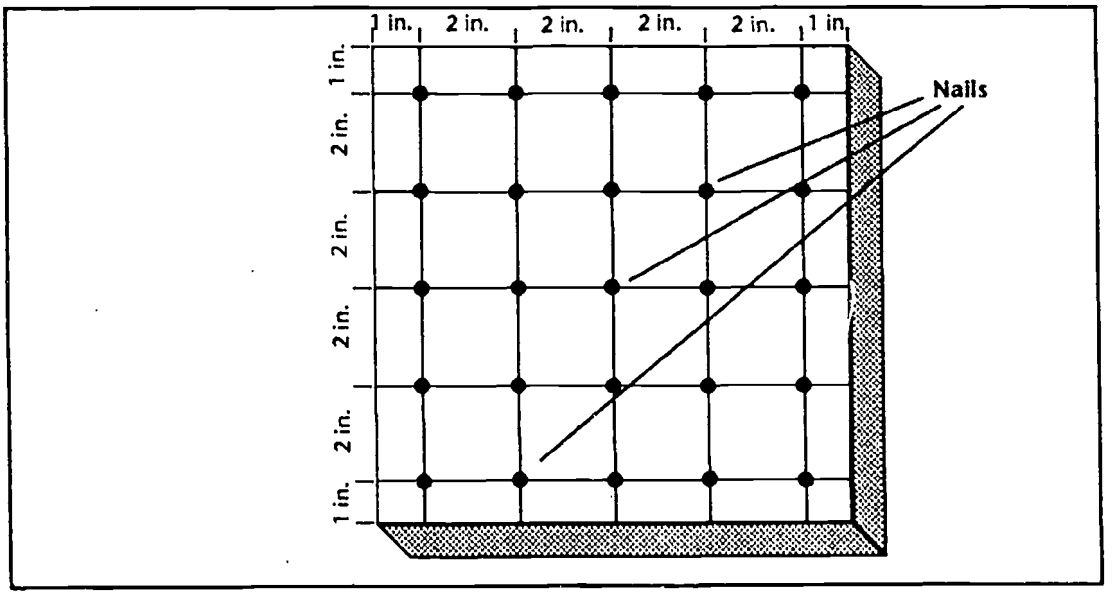
- ✓ How can a geoboard be made?
- ✓ What is perimeter?
- ✓ How can a geoboard be used to find the perimeter of a square?

MATERIALS:

6 inch by 6 inch wood square	ruler
25 small nails or tacks	rubber bands
hammer	crayon or pencil

PROCEDURES:

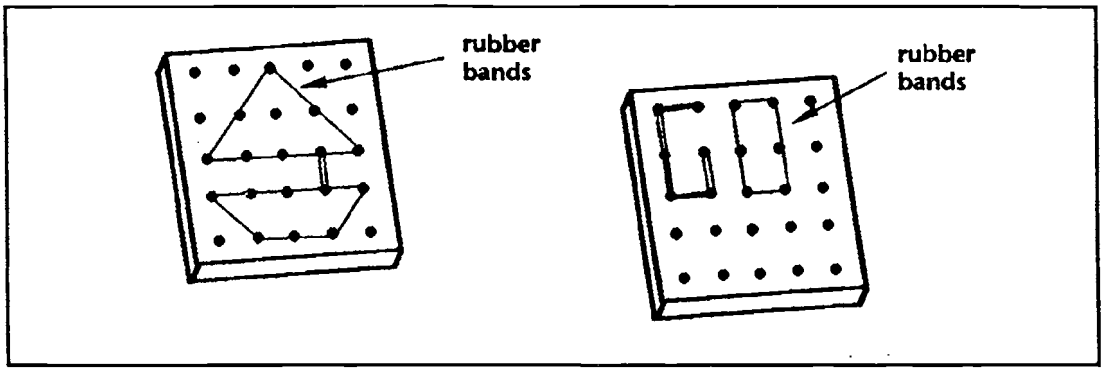
1. Measure and draw lines on the board as shown in illustration 15-1.



15 - 1

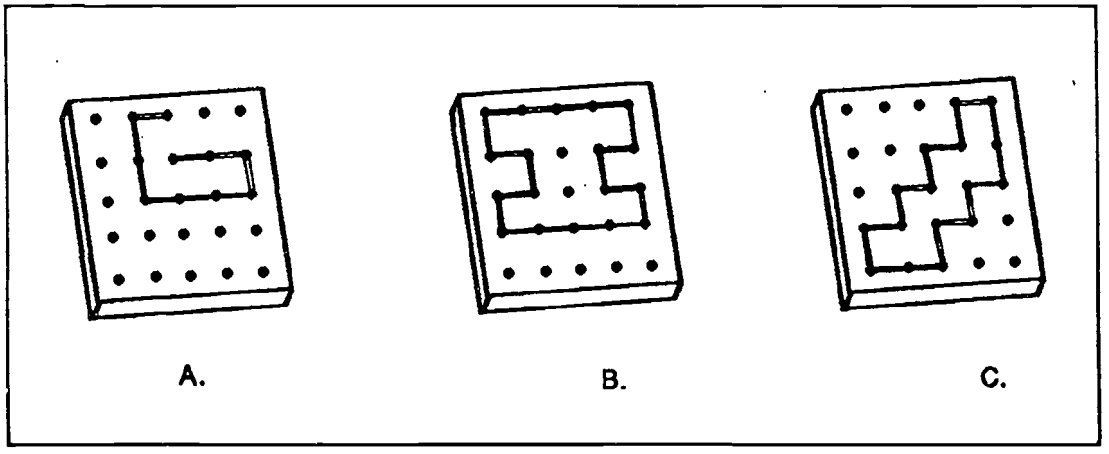
2. Use a hammer to drive the nails partly into the wood at each point where two lines cross (at the intersection of the lines).

3. Use rubber bands to make designs and words on the geoboard as in illustration 15-2.



15 - 2

4. On the geoboard, use rubber bands to make each figure shown in illustration 15-3.



15 - 3

5. How many segments or inches is it around the boundary of figures A, B, and C? The distance around the boundary is the perimeter. Record your answers on the Response Sheet.

6. Make the smallest square possible on your geoboard. Draw the square made on the geoboard on the Response Sheet. Find the perimeter of the figure. Make the largest square possible on the geoboard. Draw the square you made on the geoboard on the Response Sheet. What is the perimeter of the large square? Record both perimeters on the Response Sheet.

OBSERVATIONS:

1. What designs were you able to make on the geoboard? ***Answers vary.***
2. What designs were difficult or impossible to make? ***Answers vary.***
3. How can you find the perimeter of a square on the geoboard? ***Count the number of units [inches] around the square.***

CONCLUSIONS:

1. How does a geoboard help you find the perimeter of polygons? ***You make the polygon and then you can count the units.***
2. Why would certain shapes, such as a circle, be almost impossible to make on your geoboard? ***The rubber band makes a straight line between the nails.***
3. What are some other concepts of measure you might investigate while using a geoboard? ***Perimeter.***

SUGGESTIONS FOR FURTHER STUDY:

- Use the geoboard and rubber bands. Make as many different shapes as you can on the geoboard. Draw a picture of all the shapes you made.
- Make a shape with three sides on the geoboard. What is the shape? What is its perimeter? Make a shape with five sides. What is the shape? What is its perimeter? ***Triangle and pentagon. Perimeters vary.***
- Make a shape that has a line of symmetry, that is, each "half" of the shape looks exactly like the other half. Use a mirror on the shape you made on the geoboard to check to be sure the figure is symmetrical. ***If it is symmetrical, the reflection you see in the mirror should look like the complete shape.***
- On your geoboard, make rectangles with the following dimensions and find the perimeter of each.

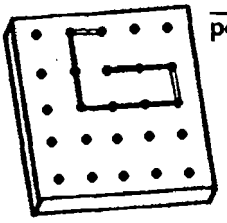
a. one unit by five units... perimeter = ***12 units***

b. two units by five units... perimeter = ***14 units***

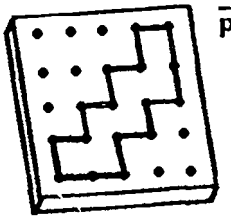
c. three units by four units... perimeter = ***14 units***

Response Sheet
Georimeter

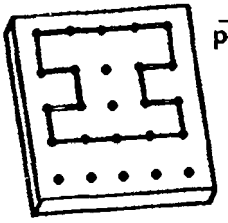
1. Perimeter or segments for the figures I made on the geoboard:



9 inches
perimeter

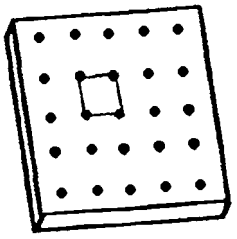


16 inches
perimeter



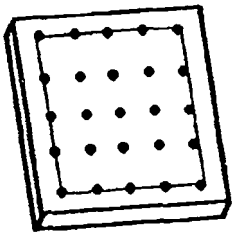
18 inches
perimeter

2.



Smallest square

4 inches
perimeter



Largest square

16 inches
perimeter

Teacher's Guide
The Pendulum Swings

GOAL: To have students explore the effect the length of the arm of a pendulum has on the number of swings the pendulum makes in 30 seconds.

STUDENT OBJECTIVES:

- ✓ To experiment with pendulums of various lengths.
- ✓ To count the number of swings pendulums with arms of various lengths make in designated times.

GUIDE TO THE INVESTIGATION: Discuss pendulum clocks with students. Point out that taller clocks have longer pendulums and the time needed to swing back and forth is affected by the length of the pendulum.

Students need a watch with a second hand or a stop watch, about 3 feet of twine or heavy string, a ball of damp clay about the size of a ping pong ball, and a thumbtack or a push pin for this exploration.

This activity should be carried out by 2 to 4 students with the guidance of an adult. The basic experiment can be done by students alone, but the adult needs to check to be sure the length of the pendulum is accurate and that students release the ball at the proper angle.

Have students follow these instructions:

1. Make a pendulum by tying a knot in one end of a 14" piece of twine. Mold a lump of clay around the knot to make a ball about one inch in diameter. Tie a loose knot in the twine to make a pendulum 12 inches long. Push the tack or push pin through the knot and into the side of a table.
2. Holding the clay ball, pull the twine out to a 90° angle.
3. Have a partner tell you when to release the clay ball.
4. When the partner tells you, let go of the clay ball and start counting the number of times the pendulum swings in 30 seconds. Your partner watches the clock or watch. Record the time on the Response Sheet.
5. Repeat the procedure with an 18 inch long pendulum. Record the results on the Response Sheet.
6. Repeat the procedures with an 8 inch long pendulum. Record the results on the Response Sheet.

Discuss the Observations and Conclusions.

VOCABULARY: pendulum, rates, swings

The Pendulum Swings

INTRODUCTION: A pendulum in a clock is set to swing a certain number of times per minute. Have you ever seen someone pull the chains on a pendulum clock? That operation determines how long the pendulum will swing. In this activity you will make a pendulum and investigate the effect of the length of the "string" and the number of swings the pendulum makes in varying amounts of time.

PURPOSE:

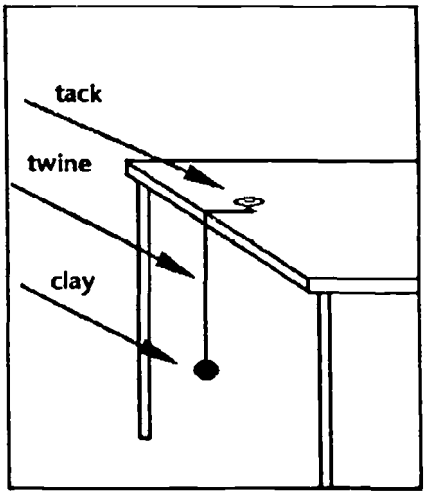
- ✓ How can a simple pendulum be made?
- ✓ What effect does the length of the string on a pendulum have on the number of times the pendulum swings?

MATERIALS:

watch with a second hand or a stop watch
3 feet of twine or heavy string
a ball of wet clay about the size of a ping pong ball
thumbtack or pushpin

PROCEDURES:

1. Make a pendulum.
   a. Tie a knot in one end of a piece of twine that is about 14 inches long.
   b. Mold a lump of clay around the knot to make a ball about one inch in diameter.
   c. Make the pendulum (the twine) 12 inches long and tie a loose knot in the free end of the twine.
   d. Put a tack through the loose knot and stick the tack into the side of a table. The clay ball must hang so it swings freely.



16 - 1

2. Pull the clay ball to the side at a 90° angle.
3. Have a partner tell you when to release the pendulum.
4. When your partner tells you to, let the pendulum go. Your partner will watch the clock or watch for 30 seconds while you count the number of times the pendulum swings. Record the number of times the pendulum swings, and the length of the pendulum twine on the Response Sheet.
5. Remove the 12 inch pendulum. Make another pendulum that is 18 inches long. Repeat the same experiment. Record the number of times the pendulum swings in 30 seconds.
6. Repeat the activity with an 8 inch pendulum.
7. Make pendulums of different lengths. Record the length of the pendulum and the number of swings it makes in 30 seconds on the Response Sheet.

OBSERVATIONS:

1. How many times did the 12 inch pendulum swing in 30 seconds?
   Answers vary.
2. How many times did the 18 inch pendulum swing in 30 seconds?
   Answers vary.
3. How many times did the 8 inch pendulum swing in 30 seconds?
   Answers vary.

CONCLUSIONS:

1. Which length of twine produced the most swings in 30 seconds?
   The shortest.
2. Which length of twine produced the least swings in 30 seconds?
   The longest.
3. What generalization can you make that reflects what you found?
   The shorter the twine, the more swings it will make; the longer the twine, the fewer swings.

SUGGESTIONS FOR FURTHER STUDY:

- Try the same activity but change the size and weight of the pendulum weight (the clay). What did you find? ***Answers vary according to material used for weight.***
- Repeat the same activity as done in the Procedures section. Instead of starting the pendulum swing at a 90° angle, try releasing the clay ball at a 45° angle, at an angle about 120°, and again at a 180° angle. What differences do these changes in starting position make? ***Angles less than 90° – make fewer swings; angles more than 90° – make more swings.***
- Make a list of everything you can that has a pendulum. Research in an encyclopedia or a book on clocks to find out how a pendulum works in a pendulum clock.

Response Sheet
The Pendulum Swings

Length of string	Swings in 30 seconds

Teacher's Guide
Exploring Rectangles

GOAL: To have students explore making various size rectangles with a loop of string or yarn and to investigate how the area of each rectangle can change while the perimeter remains the same.

STUDENT OBJECTIVES:

- ✓ To make various size rectangles with a loop of string.
- ✓ To compare length, width, perimeter, and area of various rectangles made from the same loop of string.

GUIDE TO THE INVESTIGATION: Discuss with students the concepts of perimeter and area. Relate perimeter to placing a fence around a yard and area to putting carpet on the floor.

Students need a sheet of heavy cardboard, graph paper, glue or paste, thumbtacks, a 12 inch ruler, and a piece of string or yarn approximately 30 inches long.

Students can complete this assignment individually aided by an adult or they can work in groups of three or four.
Have students complete these directions :

1. Tie the string or yarn around the length of the 12 inch ruler.
2. Glue or paste a sheet of graph paper to the cardboard.
3. Use the loop of string and the thumbtacks to make a rectangle on the cardboard and graph paper (see illustration 17-2).
4. Use the ruler to measure the length and the width of the rectangle. Record the measures on the Response Sheet.
5. Add the two lengths and two widths to find the perimeter of the rectangle. Record the perimeter on the Response Sheet.
6. Count the number of squares inside the rectangle. Record the number of squares (the area) on the Response Sheet.
7. Make other rectangles with different lengths and widths using the loop of string, the thumbtacks, and the graph paper. Find the length, width, perimeter and area of each. Record the perimeters and areas on the Response Sheet.

Discuss the Observations and Conclusions.

VOCABULARY: perimeter, area, loop

Exploring Rectangles

INTRODUCTION: You can use a loop of string to make many different shapes. The string itself is the perimeter of the shape and the space on the inside of the shape is the area. In this activity you will make several rectangles with a loop of string and explore the area of the shapes.

PURPOSE:

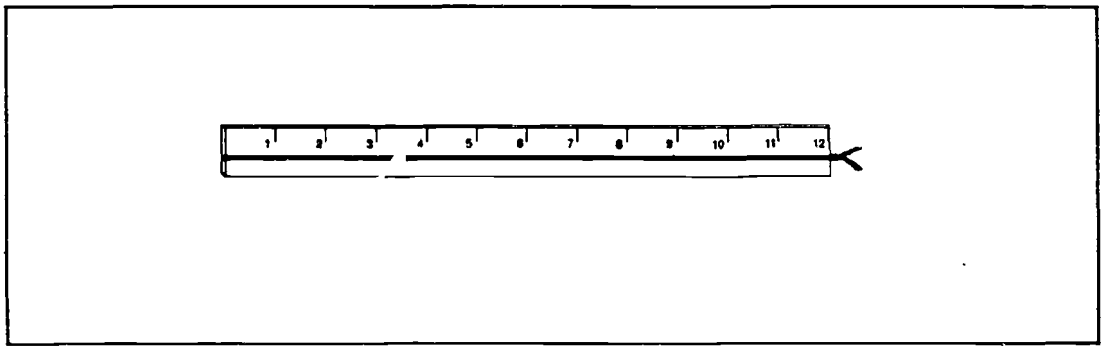
- ✓ What shapes can be made with a loop of string or yarn?
- ✓ How does the length of a shape made from a loop of string change when the width of the shape changes?
- ✓ What are perimeter and area?

MATERIALS:

heavy cardboard
graph paper
glue or paste
thumbtacks
12 inch ruler
string or yarn at least 30 inches long

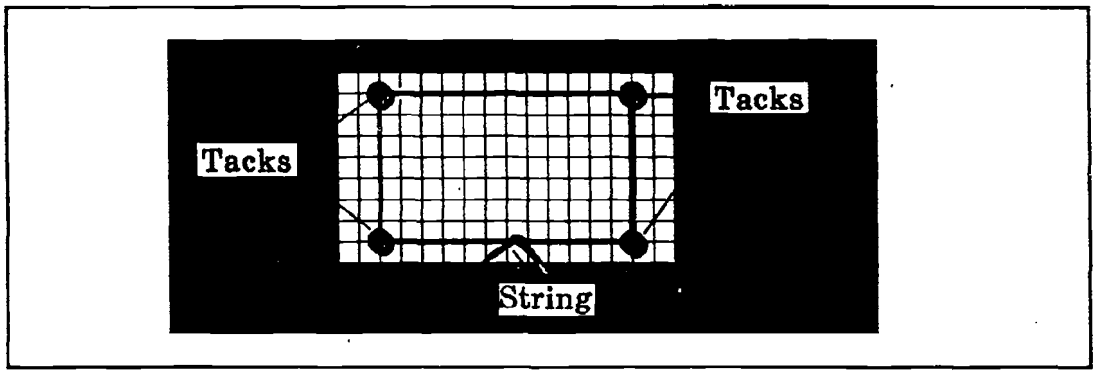
PROCEDURES:

1. Tie the string or yarn around the length of the 12 inch ruler. Tie a knot at the end as shown in illustration 17-1.



17 - 1

2. Glue or paste a sheet of graph paper to the cardboard.
3. Use the loop of string and the thumbtacks to make a rectangle on the cardboard and graph paper paper (see illustration 17-2).



17 - 2

4. Use the ruler to measure the length and width of the rectangle. Record the length and width of the rectangle on the Response Sheet.
5. Find the perimeter of the rectangle by adding the length of the sides of the rectangle. Record the perimeter on the Response Sheet.
6. Count the number of squares inside the rectangle. This is the area of the rectangle. Record the area on the Response Sheet.
7. Make other rectangles with different lengths and widths using the loop of string, the thumbtacks, and the graph paper. Find the length, width, perimeter, and area of each rectangle. Record this information on the Response Sheet.

OBSERVATIONS:

1. Were you able to make six different rectangles? ***Answers vary.***
2. What are the measures of the sides of each of the rectangles?
   Answers vary.
3. What is the name of the rectangle with sides all measuring 6 inches?
   Square.

CONCLUSIONS:

1. Which length and width combination gave the rectangle the greatest area? ***Length 6 inches; width 6 inches.***
2. Which size rectangle had the smallest area? ***Length 11 inches; width 1 inch.***
3. What happens to the area of a rectangle as the length becomes greater? ***Its area becomes smaller.***

SUGGESTIONS FOR FURTHER STUDY:

- Use the loop, thumbtacks, and graph paper on cardboard to make shapes other than rectangles. Measure the length of the sides to find the perimeter of the shapes. Then count the squares inside the loop to find the area of each shape. Which shape has the smallest area? The largest area? ***Answers vary.***
- Make several different-sized loops. Make rectangles and other shapes that have the largest and the smallest area you can make. What generalization can you make about the relationship of the area and the length and width of the shape? ***Answers vary. Possible answers may note that the closer the length and width are in size, the greater the area.***

Response Sheet
Exploring Rectangles

SHAPE	LENGTH	WIDTH	PERIMETER	AREA
Rectangle #1	*11*	*1*	*24*	*11 square units*
Rectangle #2	*10*	*2*	*24*	*20 square units*
Rectangle #3	*9*	*3*	*24*	*27 square units*
Rectangle #4	*8*	*4*	*24*	*32 square units*
Rectangle #5	*7*	*5*	*25*	*35 square units*
Rectangle #6	*6*	*6*	*24*	*36 square units*

Answers vary. Possible answers shown.

Draw each of the rectangles you made and record the length and width of each.

1 11 Rectangle #1	2 10 Rectangle #2	3 9 Rectangle #3
4 8 Rectangle #4	5 7 Rectangle #5	6 6 Rectangle #6

Teacher's Guide
Can You Balance It?

GOAL: To have students use a balance they have made to explore finding the weight of very light objects.

STUDENT OBJECTIVES:

- ✓ To make a balance.
- ✓ To find the weight of very light objects.

GUIDE TO THE INVESTIGATION: Have students discuss how much they weigh and describe the kind of scales they have used to find their weight.

Students need a 1 inch by 4 inch by 20 inch board, 2 wood blocks - 2 inches by 4 inches by 9 inches, a 4 inch by 24 inch piece of pegboard, several 2 inch nails, glue, a metal washer, 2 lids from jars (peanut butter or mayonnaise) 2 foil pans, a spool of carpet thread, and two paper clips in order to make a balance. They also need several light objects (pencil, paper clips, sugar cubes) to weigh.

This activity may be completed by individuals or groups of students with guidance from the teacher.

Have students follow these directions:

1. Glue and nail the 1 inch by 4 inch by 20 inch board between the blocks of wood as shown in illustration 18-1.
2. Looking at the pegboard lengthwise, find the hole nearest the center in the top row of holes.
3. Measure equal distances from the hole and cut off any extra board.
4. Drive a nail through the center hole of the pegboard into the upright board, centering the nail near the top.
5. Draw a line down the middle holes of the pegboard and onto the board.
6. Punch three holes in the edge of each lid as illustrated.
7. Hang the lids from the lower corner holes of the pegboard using paper clips. If the pegboard is not level, place an extra paper clip on one side of the pegboard to balance it.
8. Place one or more objects on each side of the balance until a balance is reached. For example, place two paper clips on one side of the balance.

Place one sugar cube on the other side of the balance. If there is not a balance, place another paper clip on one side or place another sugar cube on the other side.

After students experiment with the balance, discuss the Observation and Conclusion questions.

VOCABULARY: weight, balance, imbalance

Can You Balance It?

INTRODUCTION: A balance can be used to find objects that weigh the same. By placing objects on each side of a balance you can determine whether the two sets of objects weigh the same. In this activity you will build a balance and use it to find the weight of some objects.

PURPOSE:

✓ How can a balance be used to find the weight of very light objects?

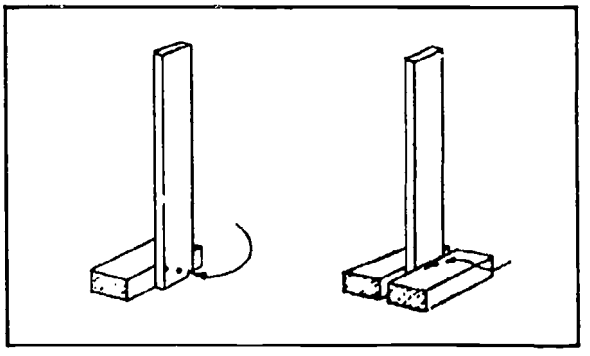
MATERIALS:

several light objects (pencil, paper clips, sugar cubes)
1 inch by 4 inch by 20 inch board
two wood blocks measuring 2 inches by 4 inches by 9 inches
one 4 inch by 24 inch piece of pegboard
several 2 inch nails
two foil pans
two paper clips
spool of carpet thread
glue
metal washer
two lids from jars (peanut butter or mayonnaise)

PROCEDURES:

Make a balance following the directions. Use the illustrations to help you.

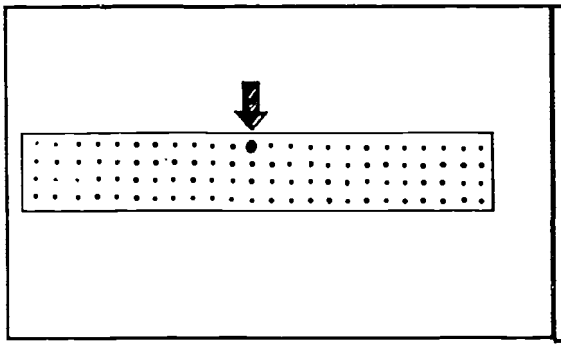
1. Glue and nail the 1 inch by 4 inch by 20 inch board between the two blocks of wood as shown in illustration 18-1.



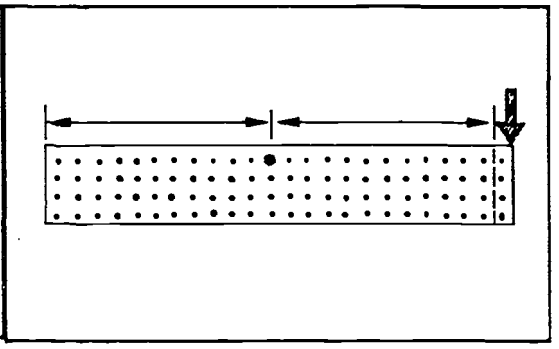
18 - 1

2. Looking at the pegboard lengthwise, find the hole nearest the center in the top row of holes, as shown in illustration 18-2.

3. Measure equal distances from the hole and cut off any extra, as shown in illustration 18-3.



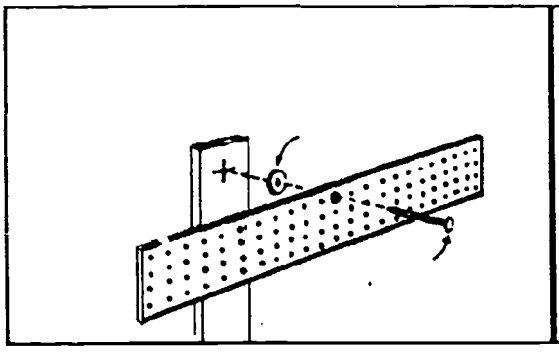
18 - 2



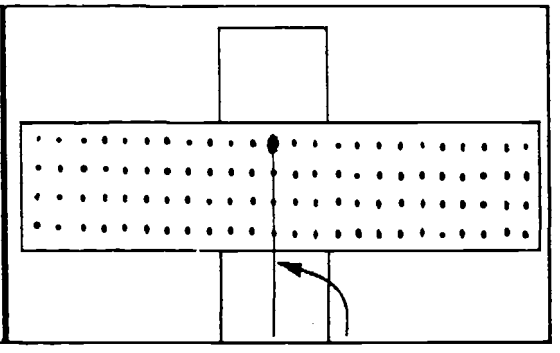
18 - 3

4. Drive a nail through the hole in the upright board, centering the nail near the top as shown in illustration 18-4.

5. Draw a line down the middle holes of the pegboard and onto the board, as shown in illustration 18-5.

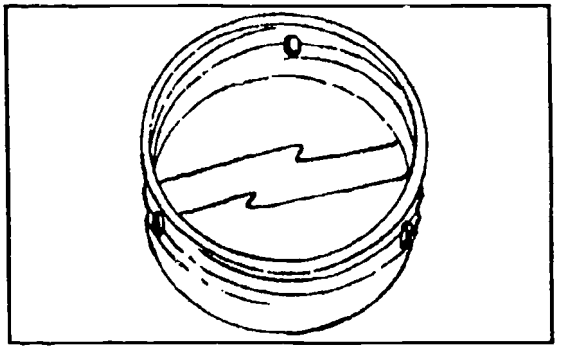


18 - 4



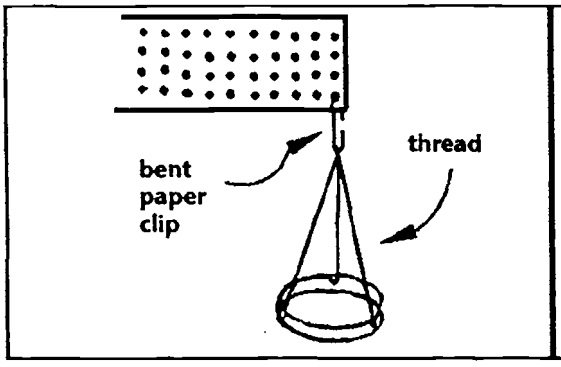
18 - 5

6. Punch 3 holes, evenly spaced, in the edge of each lid, as shown in illustration 18-6.

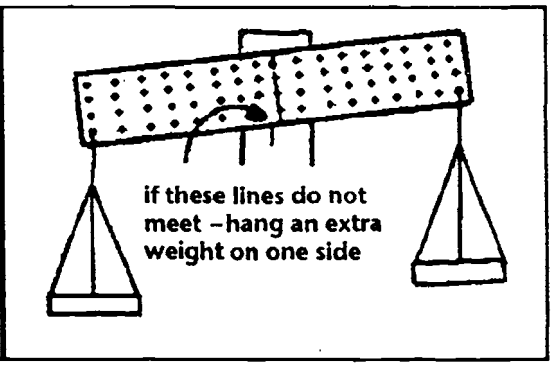


18 - 6

7. Hang the lids from the lower corner holes of the pegboard using paper clips and thread as shown in illustrations 18-7 and 18-8. If the pegboard is not level, place an extra paper clip on one side of the pegboard).



18 - 7



18 - 8

8. Place one or more objects on each side of the balance until it "balances." For example, place 2 paper clips on one side of the balance and a sugar cube on the other side. If there is not a balance, place another paper clip on one side or another sugar cube on the other.

9. Make several drawings on the Response Sheet that show the balance when there is a balance and when there is not a balance.

OBSERVATIONS:

1. What "things" did you make balance? ***Answers vary.***

2. What did you have to do to make a balance? ***Answers vary.***

3. How did you know when it was balanced? ***Answers vary. Possible answers may be that the center lines matched, or the two lids hung at the same level.***

CONCLUSIONS:

1. Can you just look at items and decide whether or not they will make a balance on the balance? Why or why not? ***No. You can't tell what something weighs by looking at it.***

2. What advice could you give to a friend about using a balance? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

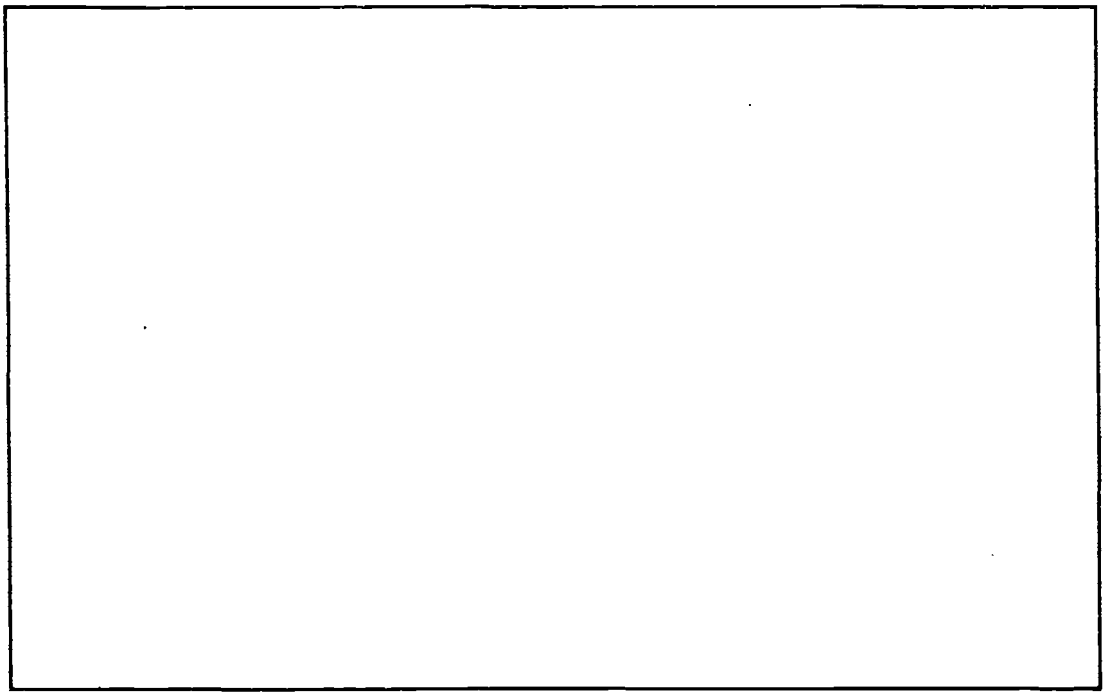
- Place other light objects, such as coins or thumbtacks, on the balance. Make a chart that shows which items make a balance. Your chart could look like this:

Number of items		Number of items
1 nickel	=	8 thumbtacks

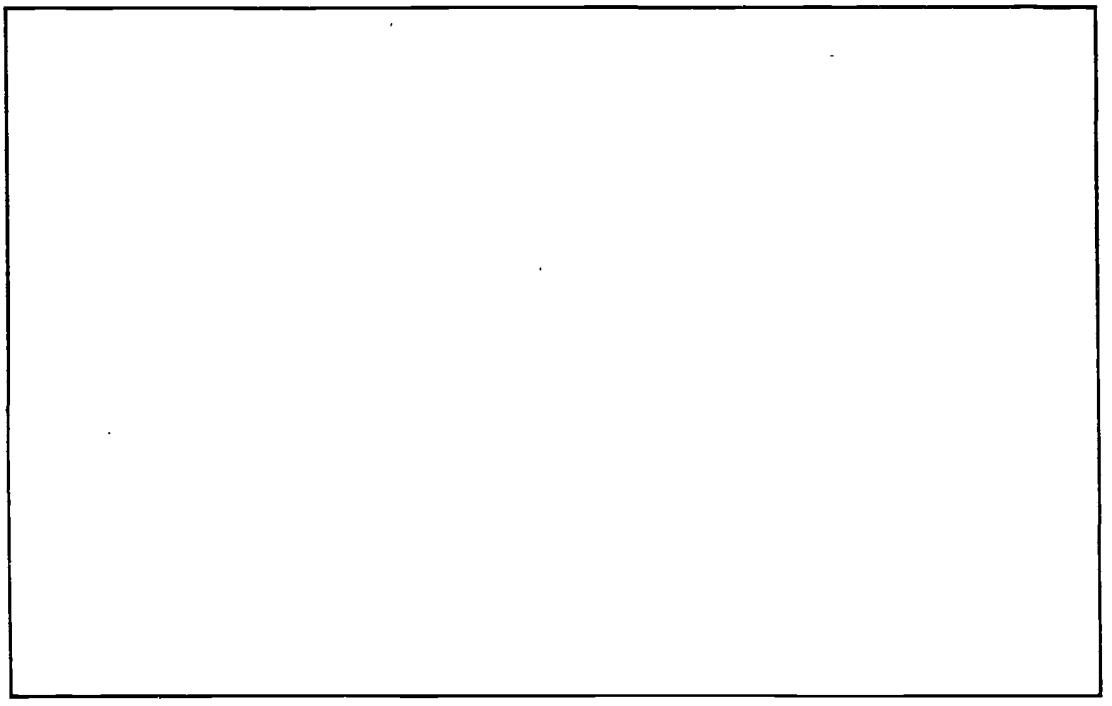
- Try to find a pan balance in your library or math room. Repeat the activities of balancing heavier objects such as a chalkboard eraser and a shoe, a notebook and your math book. Which sets balance? What can you do to make a balance? ***Answers vary. Continue placing objects on the side that is lighter.***

Response Sheet
Can You Balance It?

Balance showing an imbalance



Balance showing a balance



NUMBER SENSE

Teacher's Guide
Dot Bingo

GOAL: To have students explore using dot cards to gain a better understanding of addition.

STUDENT OBJECTIVES:

- ✓ To make a game using dot cards.
- ✓ To play the dot card game for addition.

GUIDE TO THE INVESTIGATION: Discuss addition with students. Remind them that when you add you put things together.

Students need 20 index cards, markers, checkers or beans, a ruler, and four or more bingo-type cards made from posterboard.

This activity can be completed by pairs of students under the guidance of an adult. Since it takes a long period to prepare the dot cards, small groups can work together to prepare the cards. However, the game should be played by two students at a time.

Have students follow the directions shown in the Procedures section.

1. Make dot cards, two for each number, one through nine as shown in illustration 19-1.
2. Make four bingo type cards from poster board as shown in illustration 19-2. Cut four squares from poster board. Measure and divide each square into nine cells. Write numbers in the cells as shown.
3. Play a game with a partner using the rules shown on the activity sheet.

The students should discuss the rules of the game before they play. After completion of the activities and games, discuss the Observations and Conclusions.

VOCABULARY: addition, dot cards

Dot Bingo

INTRODUCTION: It is fun to play games. Games can help you understand ideas in mathematics. In this activity you will make dot cards and use bingo type cards to find the sum for addition exercises.

PURPOSE:

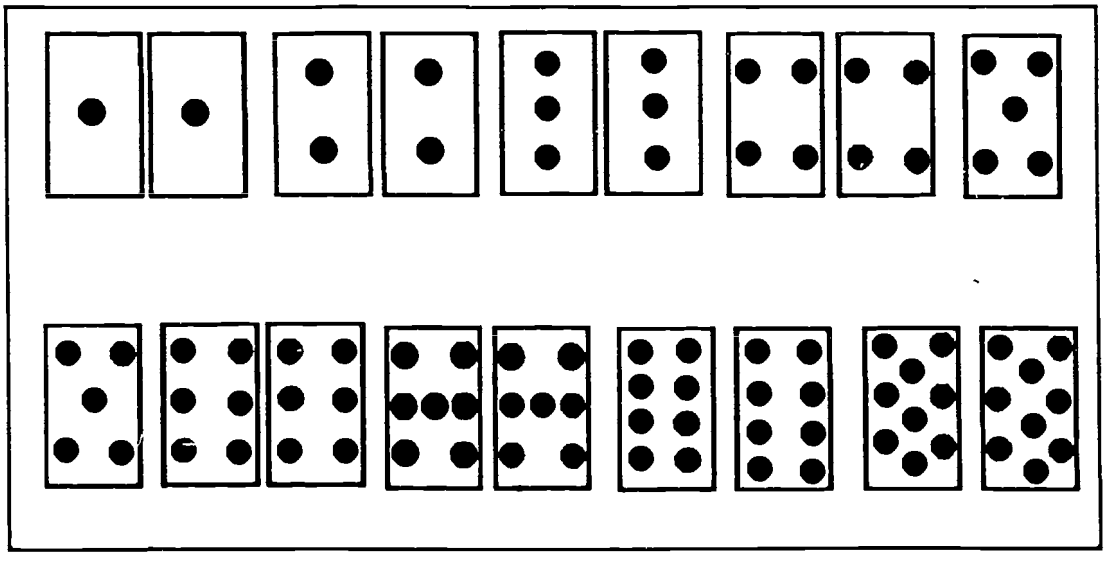
- ✓ How can a dot bingo game be made?
- ✓ How can the dot bingo game be used to gain an understanding of addition?

MATERIALS:

20 index cards
markers
checkers or beans
4 bingo type cards made from poster board
ruler

PROCEDURES:

1. Make the dot cards, two for each number, one through nine, as shown in illustration 19-1. Use a marker and make large, dark dots.



19 - 1

2. Follow these directions to make the four bingo type cards, as shown in illustration 19-2.

   Cut four squares from poster board. Measure and divide each square into 9 cells. Write numbers in the cells as shown.

12	8	2
7	9	4
10	13	5

8	14	7
9	15	3
11	13	6

10	6	18
13	15	11
8	2	17

7	6	17
15	4	16
5	10	3

19 - 2

3. Play a game with a partner, using these rules:
    a. Each player selects a bingo card. Mix the dot cards and turn them face down.
    b. The first player draws two dot cards and adds the dots.
    c. If the sum of the dots is shown on the bingo card selected, place a checker or bean on the sum.
    d. Take turns.
    e. The winner is the player who first covers all sums on the card.

OBSERVATIONS:

1. Does playing the game help you learn to add faster and better? ***Yes.***
2. Can this game be modified to help you practice addition with sums larger than 18? How? ***Yes, by putting larger sums on the cards.***

CONCLUSIONS:

1. How can this game, using dot cards and bingo type cards, be changed so you can use the game to subtract? ***Make new cards that would have numbers in the boxes equal to differences between dot cards.***
2. How can games like dominoes and bingo help you become better at adding? ***You have fun playing the game while you are practicing addition facts.***

SUGGESTIONS FOR FURTHER STUDY:

- Make a multiplication game using dot cards. Write a description of materials needed to make the game, and write the rules for playing at least two games. Choose a friend to help you make the games and play with you. Then play the games you made up. Which game worked best? Why? Were the rules clear? Did the game teach or reinforce the skills you intended it to do? ***Answers vary.***
- Play dominoes with a friend. Discuss what you and your friend are learning about addition when playing dominoes. What other skills are you practicing while playing dominoes? ***Counting, matching, one-to-one, etc.***

Teacher's Guide
An Adding Machine

GOAL: To have students develop an understanding of how to operate an "adding machine".

STUDENT OBJECTIVES:

- ✓ To construct an "adding machine".
- ✓ To add 2 one-digit numbers using the adding machine.
- ✓ To add one-digit and two-digit numbers using the adding machine.

GUIDE TO THE INVESTIGATION: Ask students what manipulative they use to help them add and subtract. Have them discuss using various kinds of counters in adding and subtracting. Several students should demonstrate how to use counters to add.

Students need two 24-inch or two 30-centimeter rulers.

This activity should be directed by the teacher with younger students or can be carried out with pairs of older students.

Have students follow the directions in the Procedures section.

1. Place the two rulers side by side with the edges touching.
2. Add 5 plus 8 on the adding machine by following these steps:

   Place the zero (0) on ruler A over the 8 on ruler B. Find the 5 on ruler A. The number below the 5 (on ruler B) is 13, so 8+5 is 13.

Discuss the Observations and Conclusions.

VOCABULARY: add, digits, ruler, adding machine

An Adding Machine

INTRODUCTION: You have used counters to help you add, but there are other manipulatives that can help you add. A ruler is used to measure length, but you can use two rulers to make an adding machine.

PURPOSE:

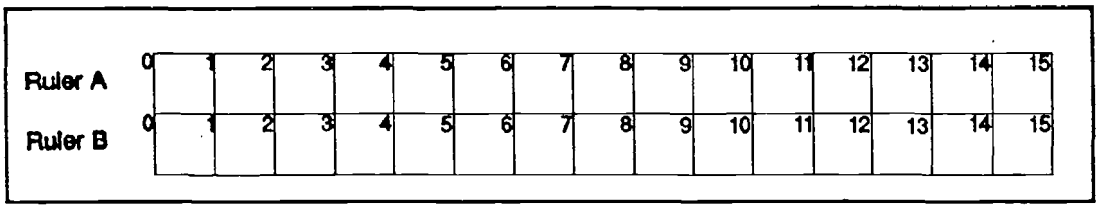
- ✓ How can you find the sum of one and two digit numbers using rulers?
- ✓ How does an adding machine made with rulers work?

MATERIALS:

two 24 inch or two 30 centimeter rulers

PROCEDURES:

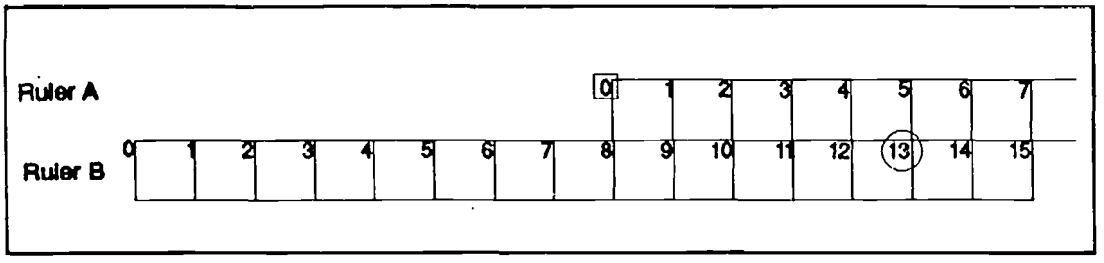
1. Place the two rulers side by side with the edges touching.



20 - 1

2. Add 5 + 8 on the adding machine, like this: Slide ruler A so that its 0 is over the 8 on Ruler B.

   Find the 5 on Ruler A. Slide your finger from the 5 on Ruler A to the number below on Ruler B. The number is 13, so 5 + 8 =13.



20 - 2

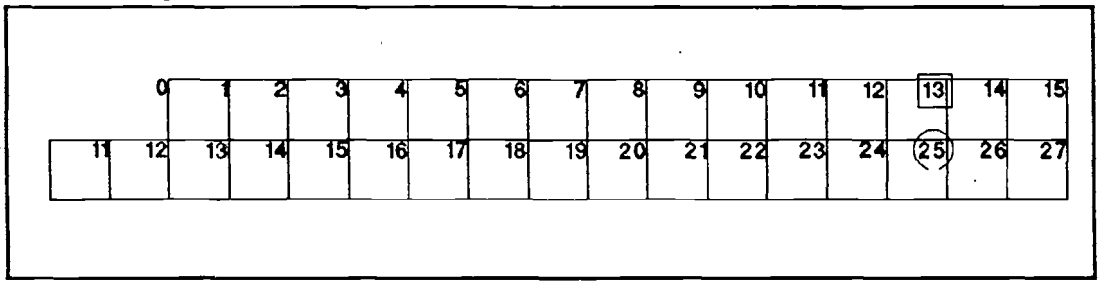
OBSERVATIONS:

1. What is the sum of 9+6? How can the adding machine show the sum? Draw a picture in the first box on the Response Sheet to show how the adding machine is arranged when you add 9 and 6. ***15***
   Answers vary.

2. What is the sum of 4+12? How can the adding machine show the sum? Draw a picture on the Response Sheet that shows how the adding machine looks. ***16. Answers vary.***

CONCLUSIONS:

1. In the drawing below, what numbers have been added on the "adding machine"? ***13 and 12.***



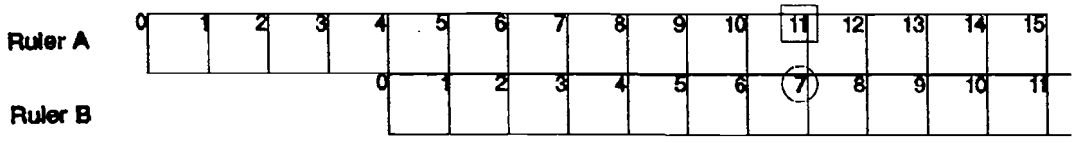
20 - 3

2. Can your adding machine be used to add three digit numbers? Why or why not? ***No. Answers vary. Possible answer may be that there are no three-digit numbers on a ruler.***

3. Write your own directions for using the adding machine. ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

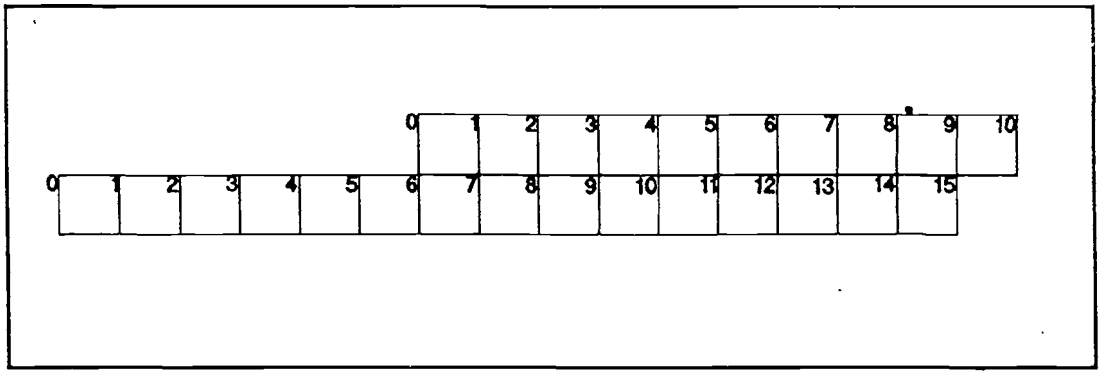
- You can subtract using the adding machine. Place the rulers side by side to subtract 11 - 4.
  Place the 0 on Ruler B below the 4 on Ruler A. Then find 11 on Ruler A. The 7 on Ruler B below the 11 on Ruler A shows that 11 - 4 = 7.



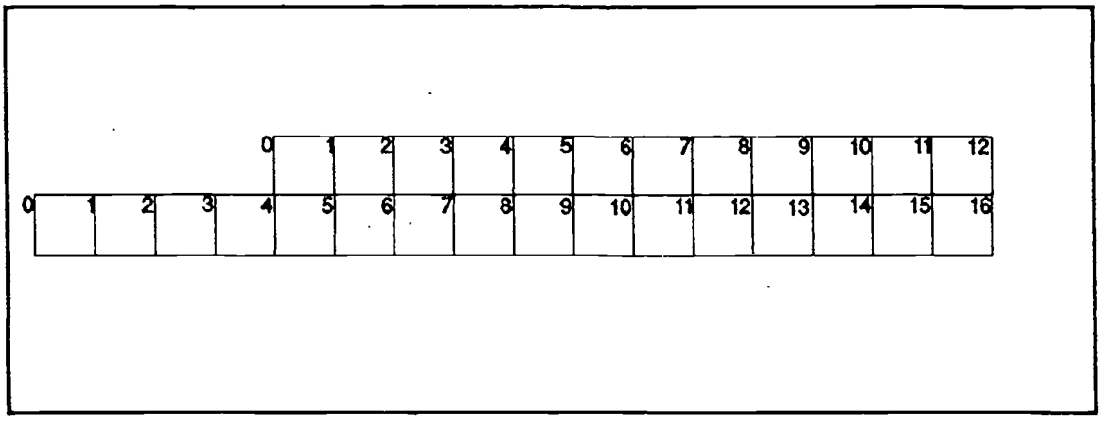
- Find the difference for 15 - 6 and 16 - 7 on your "adding machine". Then draw a picture of how your adding machine appears when you subtract 15 - 6.

Response Sheet
An Adding Machine

1. A drawing showing 9+6 on the adding machine.



2. A drawing showing 4+12 on the adding machine.



3. Write or draw how the adding machine works.

Teacher's Guide
Show Me A Thousand

GOAL: To have students explore ways of making one thousand and gain an understanding of the concept of thousand.

STUDENT OBJECTIVES:

- ✓ To count one thousand things in an organized way.
- ✓ To show one thousand things.

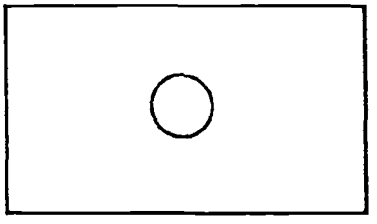
GUIDE TO THE INVESTIGATION: Ask students to describe what they think one thousand is, what things come in thousands and how they think one thousand of something can be shown.

Materials for this investigation include paper, pencils, small pebbles, several different sized boxes, several pages of newspaper, approximately 500 pennies in an open container, and other small objects.

Students should work in small groups to complete this investigation. Each group of 4 or 5 students should make and count a thousand and make a prediction of how many groups or containers filled with various items are needed to make a thousand.

Have each group follow these directions:

1. Draw many small circles (about the size in illustration 21-1) on a sheet of paper to fill the sheet. Count the circles. Try to figure out how many pages of circles it will take to make 1000 circles. Record your prediction and the number on the Response Sheet.



21 - 1

2. Fill a small box (measuring about 2 inches by 3 inches by 6 inches) with small pebbles. Count the number of pebbles it takes to fill the box. Record the number on the Response Sheet. Predict the number of boxes needed to hold 1000 pebbles. Record the number on the Response Sheet.
3. Fill a larger box with pebbles. Count them. Guess how many larger boxes of pebbles are needed to hold 1000 pebbles. Record the count and guess on the Response Sheet.

4. Find a short article in the newspaper. Count the number of words in the article. Guess how many short articles are needed to make an article of 1000 words. Record the count and guess on the Response Sheet.
5. One member of the group should pick up a large handful of pennies from a large container of pennies. Count the pennies in one handful. Record the number on the Response Sheet. Write the number of handfuls of pennies each member of your group thinks are needed to make 1000.

Discuss the Observations and Conclusions.

VOCABULARY: thousand

Show Me A Thousand

INTRODUCTION: Many things cost $1000. There are certainly many thousands of grains of sand on a beach. Have you ever seen exactly 1000 of something? In this activity you will count various items and numbers and figure out how many are needed to make 1000.

PURPOSE:

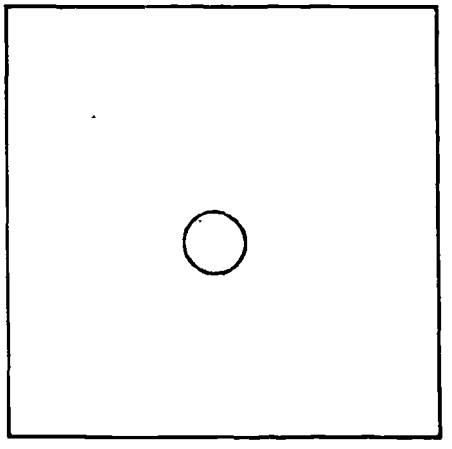
- ✓ How can you approximate 1000 items without actually counting 1000 things?
- ✓ What are several ways to show 1000?

MATERIALS:

paper
pencil
small pebbles
various sized boxes
several newspaper pages
sand
approximately 500 pennies in an open container
other small objects

PROCEDURES:

1. Work with a group. Each of you should draw many small circles (about the size shown in illustration 21-2) on a sheet of paper. Count the circles. Try to figure how many pages of circles it would take to make 1000 circles. Record your prediction and the actual number on the Response Sheet.
2. Fill a small box (about 2 inches by 3 inches by 6 inches) with small pebbles.



21 - 2

Count the number of pebbles it takes to fill the box. Record the number on the Response Sheet. Predict the number of boxes needed to hold 1000 pebbles. Record your prediction on the Response Sheet.

3. Fill a larger box with pebbles. Count them. Guess how many larger boxes of pebbles are needed to hold 1000 pebbles.
4. Find a short article in the newspaper. Count the number of words in the article. Guess how many short articles are needed to make an article containing 1000 words. Record the count and guess on the Response Sheet.
5. Have one member of your group pick up a handful of pennies from a large container of pennies. Count the pennies in one handful. Record the number of pennies on the Response Sheet. Figure how many handfuls of pennies are needed to make 1000 pennies. Record the number on the Response Sheet.

OBSERVATIONS:

1. How many sheets of paper with circles drawn on them are actually needed to show 1000 circles? How can you find out? ***Answers vary.***
2. How many small boxes of pebbles are actually necessary to hold 1000 pebbles? How can you find out? ***Answers vary.***
3. How many large boxes of pebbles are actually necessary to hold 1000 pebbles? How can you find out? ***Answers vary.***
4. How many short articles are actually needed to make an article with 1000 words? How can you find out? ***Answers vary.***

CONCLUSIONS:

1. When you were doing the activities to find how many make 1000, what conclusions could you draw about each of these? ***The smaller the circles, pebbles, pages, or boxes, the more are needed.***
   - ✓ the size of circles drawn to fill a page
   - ✓ the size of pebbles
   - ✓ the size of boxes holding pebbles
   - ✓ the number of pennies in someone's hand
   - ✓ the words in an article

SUGGESTIONS FOR FURTHER STUDY:

- Go on a scavenger hunt to find something you can collect 1000 of such as plastic caps from gallon milk cartons. Start collecting the item you have chosen. Devise a way to store the items so it is easy to keep a count of the items as you collect them. After you have collected the items for a week, predict how long it will take you to collect 1000 items.
- How many paper clips are needed to fill an empty school milk carton? Once you have filled an empty carton with paper clips, predict how many cartons it will take to hold 1000 paper clips. Write a story and draw pictures showing how you decided on the number of cartons needed.

Response Sheet
Show Me A Thousand

1. Number of circles on one page _____
2. Number of pages needed to have 1000 circles _____
3. Number of pebbles in one small box _____
4. Number of small boxes of pebbles needed to hold 1000 pebbles _____
5. Number of pebbles in one large box _____
6. Number of large boxes of pebbles needed to hold 1000 pebbles _____
7. Number of words in a short article _____
8. Number of short articles needed to equal 1000 words _____
9. Number of pennies in a handful _____
10. Number of handfuls of pennies needed to make 1000 _____

All answers vary, depending on the size of page, pebbles, boxes, hand, and number of words in an article.

Teacher's Guide
Making A Hundreds Frame

GOAL: To have students investigate and make a hundreds frame and to make and read three-digit numbers on the frame.

STUDENT OBJECTIVES:

- ✓ To make a hundreds frame.
- ✓ To use a hundreds frame for counting and understanding numbers larger than ten.

GUIDE TO THE INVESTIGATION: Discuss with students that 10 pennies and a dime have the same value and that 10 dimes and a dollar have the same value. Students who understand these concepts will enjoy this activity. For students who do not understand the concepts, this investigation will present new insights into the concepts of regrouping.

Students need white paper, pencil, scissors, die, dried beans or unpopped popcorn for the investigation.

This investigation can be carried out by individual students but it is probably better for pairs of students to work together because of the role dialogue between students plays in helping them understand the concepts of the lesson. Adult assistance is necessary for younger students.

Direct students to follow these directions:

1. Trace the 100 frame and cut it out.
2. Trace 10 tens frames and cut them out.
3. Roll the die.
4. Count out as many beans as are shown on the die.
5. Roll the die again.
6. Once you get 10 beans, trade them in for a tens frame. Put the tens frame on the hundreds frame.
7. Continue playing until the hundreds frame is filled.
8. Play with a partner. Take turns rolling the die and filling the tens frame and hundreds frame. (Each student should make and use his own set of frames). Take turns, see who can fill their hundred frame first.

Discuss the Observations and Conclusions.

VOCABULARY: hundred, frame

Making A Hundreds Frame

INTRODUCTION: How many pennies make a dime? How many dimes make a dollar? This activity is like exchanging 10 pennies for a dime and 10 dimes for a dollar. You will make a hundreds frame and 10 tens frames and play a game. In the game you will exchange ten beans for tens frames and ten tens frames for a hundreds frame.

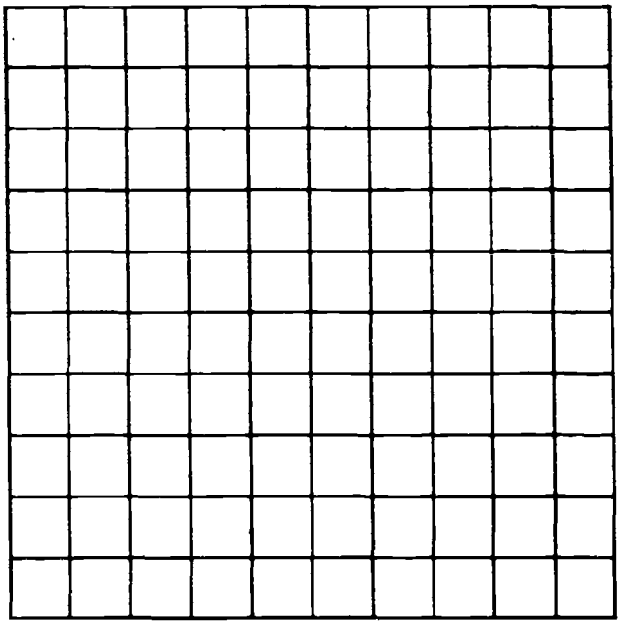
PURPOSE:

- ✓ What is a tens frame?
- ✓ What is a hundreds frame?
- ✓ How can a hundreds frame help in counting and understanding numbers larger than ten?

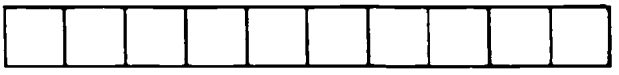
MATERIALS:

dry beans or unpopped popcorn
white paper
pencil
scissors
die

100s frame



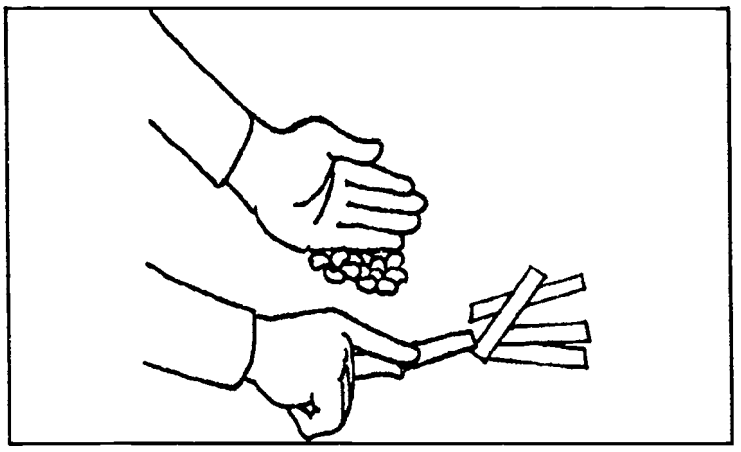
10s frame



PROCEDURES:

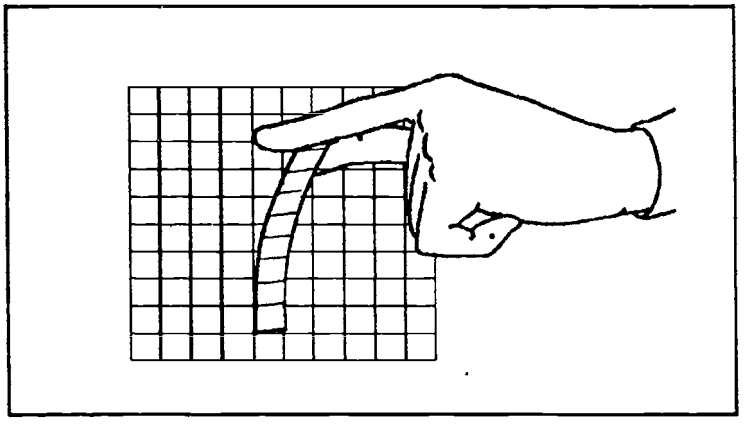
1. Trace the hundreds frame and cut it out.
2. Trace 10 tens frames and cut them out.
3. Roll the die.
4. Take as many beans as the number shown on the die. For example, if the die shows 4, take 4 beans
5. Roll the die again.

6. Once you get 10 beans. Trade them in for a ten frame. Put the tens frame on the hundreds frame.
7. Continue playing until your hundred frame is filled.



22 - 1 *Trade 10 beans for a tens frame.*

8. Play with a partner. Take turns rolling the die and filling the tens frames and hundreds frame. Each should make a set of frames. Take turns, see who can fill their hundreds frame first.
9. Keep a record of your rolls on the Response Sheet.



22 - 2 *Place tens frames on the hundreds frame to fill it.*

OBSERVATIONS:

1. How many beans should be placed on a tens frame? *10*
2. How many tens frames will fill a hundreds frame? *10*
3. How many beans would it take to fill a hundreds frame? *100*

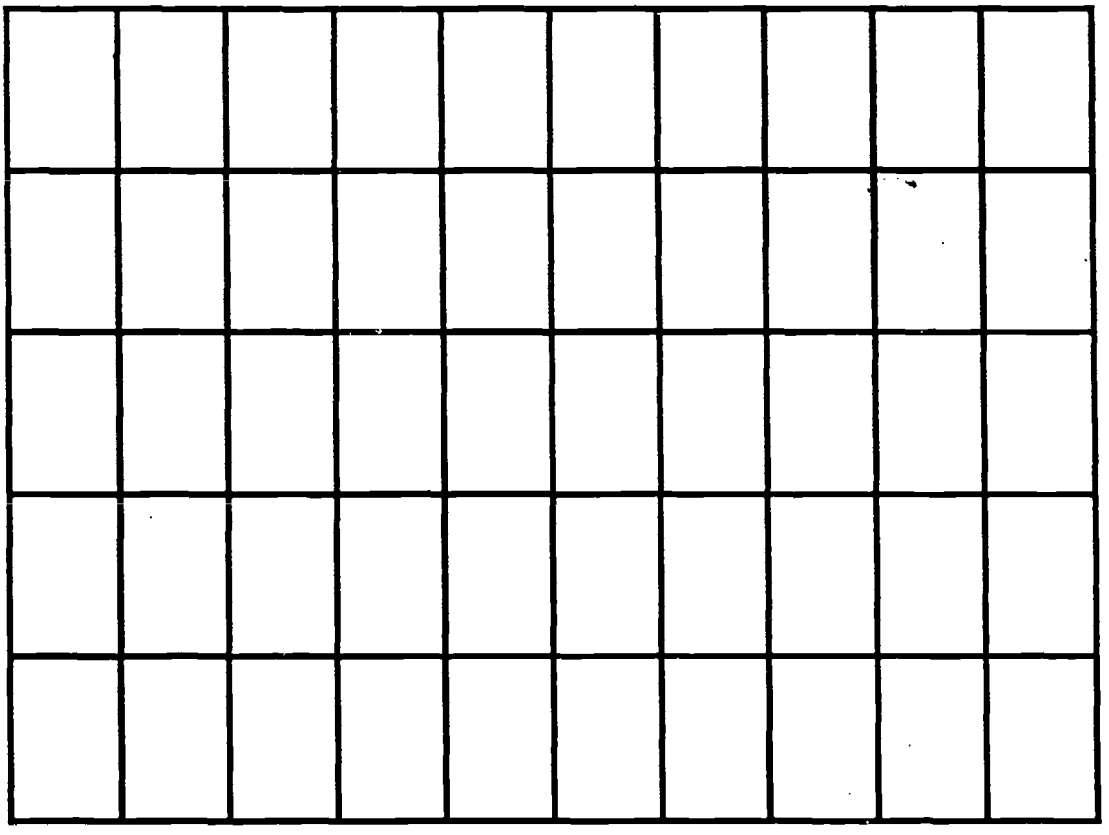
CONCLUSIONS:

1. How can you write a number represented by one roll of the die?
   With one digit.
2. What number is represented by two tens frames? *20*

3. How can you write a number made by several tens frames and some beans? ***As two-digit numbers.***

SUGGESTIONS FOR FURTHER STUDY:

- Make a game board like the one below for each player for a game called "Fill-er- Up". Use the die and the beans. The first player rolls the die and uses beans to cover the number of squares on the game board that was rolled on the die. The second player repeats the roll of the die. This continues until all players have had a turn. Then the first player rolls again and places that number of beans on the game board. Play continues for the second, third, player, etc. The first player to "fill-er-up" wins the game.



Response Sheet
Making A Hundreds Frame

Score Sheet
Player 1
How many times did you trade beans for a tens frame? _____
How many tens frames were needed to fill a hundreds frame? _____
Player 2
How many times did you trade beans for a tens frame? _____
How many tens frames were needed to fill a hundreds frame? _____

Teacher's Guide
Money Code

GOAL: To give students experience in counting and adding the value of pennies, nickels, and dimes, and to allow them to explore the use of codes.

STUDENT OBJECTIVES:

- ✓ To make money tags.
- ✓ To find the "value" of names (words) when letters have assigned values.
- ✓ To explore the value of various combinations of coins.

GUIDE TO THE INVESTIGATION: Display pennies, nickels, and dimes on an opaque or overhead projector. Have students tell the value of each coin. Review simple combinations of coins such as a nickel and 3 pennies equals 8 cents.

Students need paper, pencil, scissors, lots of pennies, several nickels, and several dimes to complete this activity.

This activity can be completed by individual students or pairs of students who have an understanding of the value of a penny, nickel, and dime. For students who do not understand the value of the coins, adult guidance is needed.

Have students follow these directions:

1. Cut square pieces of paper to make money tags about the size shown in illustration 23-1.
2. Write a letter and money value on each piece of paper.
3. Place coin amounts on the money tags. For example, 8 cents = 1 nickel and 3 pennies.
4. Pick out the money tags for the letters in your first name. You may need to make more money tags for some letters.
5. Count the value of the coins. What is the value of your first name?
6. Repeat the activity for your last name.

Discuss the Observations and Conclusions.

VOCABULARY: penny, nickel, dime

Money Code

INTRODUCTION: Coins have different values. To count coins easily, you can start with coins of larger value and then count the coins with smaller values. In this activity you will count the value of coins and find the "value" of your name.

PURPOSE:

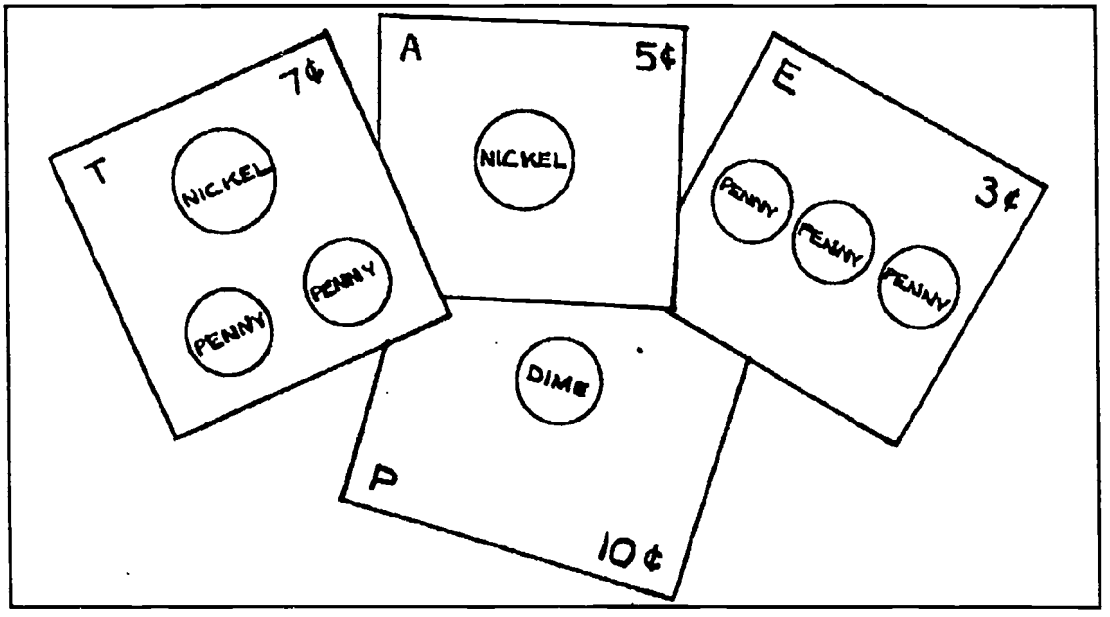
- ✓ How can you find the value of your first and last names using coins and money tags when letters have been assigned values?
- ✓ How can this coin activity help reinforce an understanding of addition of pennies, nickels, and dimes?

MATERIALS:

paper
pencil
scissors
lots of pennies
several nickels
several dimes

PROCEDURES:

1. Cut pieces of paper to make money tags about the size shown.



23 - 1

2. Use the following code. Write a letter and money value on each piece of paper.

A = 5¢	G = 7¢	M = 5¢	S = 3¢	Y = 9¢
B = 2¢	H = 10¢	N = 1¢	T = 7¢	Z = 2¢
C = 10¢	I = 6¢	O = 4¢	U = 1¢	
D = 1¢	J = 1¢	P = 10¢	V = 6¢	
E = 3¢	K = 2¢	Q = 2¢	W = 3¢	
F = 2¢	L = 4¢	R = 5¢	X = 5¢	

3. Place coins on the money tags to equal the value shown; that is 10¢ = 2 nickels, or 1 nickel and 5 pennies, or 1 dime.
4. Pick out the money tags for the letters in your first name. If you need to make more money tags for some letters, do so.
5. Count the value of the coins shown on the money tags. Start with the coins with larger values, then add on the coins with smaller values.
6. Try the same thing with your last name.
7. Write your first and last name on the Response Sheet. Write the value by each letter. Write the total value for your name.
8. Write the first names of two other members of your family. What is the value of their names?
9. Write the name of a partner on the Response Sheet. Find the value of your partner's name. Whose name has the greatest value?

OBSERVATIONS:

1. Which has the greater value, your first name or your last name?
   Answers vary.
2. Which family member's name has the greatest value? Why?
   Answers vary. The "value" depends on the number of letters in a name and the assigned value of the letters.

CONCLUSIONS:

1. Is it easier to start with the value of the large coin and then add on the value of the smaller coins or start with the value of the smaller coin? Why? ***Start with the value of larger coin. Reasons vary.***

2. What can you do to change this activity to get a greater or lesser value for your name? ***Change the value of the letters.***

SUGGESTIONS FOR FURTHER STUDY:

- Use your money tags and coins. Find which day of the week has the highest money value. Guess, then check. ***Thursday.***
- Repeat the same procedures with the months of the year. Guess which will have the least value and which will have the greatest value. Why do you think so? Check it out! ***September.***
- Make more words using your money tags. Count the coins and find the money value of each word. Are longer words always worth more than shorter words? Why or why not? ***Answers vary. The value of words depends on the value of the letters.***

Response Sheet
Money Code

1. Write your first name. *All answers vary.* _____

2. Place the money tags in order to show your name. Write the value of each letter; for example:

J	O	Y	
1¢	4¢	9¢	= 14¢

What is the value of your first name? _____

3. What is the value of your last name?

_____

4. Two members of my family and the values of their names:

_____

_____

5. My partner's name and its value:

_____

6. How can you guess or predict which names have a greater value?

_____

_____

7. How can the money tags be changed to increase or decrease the value of "words"? *Change the value of the letters.*

_____

_____

CONNECTIONS

Teacher's Guide
Blob Art

GOAL: To have students explore making various art "blobs" that show symmetry and to gain an understanding of symmetry and lines of symmetry.

STUDENT OBJECTIVES:

- ✓ To create "blob" art pictures.
- ✓ To locate lines of symmetry.

GUIDE TO THE INVESTIGATION: Discuss the concept of symmetry with students. Demonstrate how figures such as circles and squares can be folded in half and each half will be identical. Explain that the fold is called the line of symmetry.

Students need construction paper, a brush, several colors of paint, a pencil, crayons, scissors, magazines, tape, glue, or paste for the exploration. This activity can be completed by individual students or small groups of 3 to 4 students with the guidance of an adult.
Have students follow these directions:

1. Blob several different colors of paint on a sheet of construction paper. Make the blobs touch or overlap.
2. Fold the construction paper in half and press the folded paper flat.
3. Unfold the paper and look at the blob picture you made. What do you see?
4. On the Response Sheet make a drawing of the symmetrical figure you made. Make a line where the figure was folded.
5. Write several sentences on the Response Sheet that describe your symmetrical figure.
6. Look in a magazine to find pictures you think show symmetry. Cut the picture from the magazine. Fold it in the center, either "across" or "up and down". Look closely, does the picture have symmetry?
7. Glue the symmetrical picture on the Response Sheet.
8. Find a picture that does not have a line of symmetry. Paste or glue it on the Response Sheet.

Discuss the Observations and Conclusions.

VOCABULARY: symmetry, line of symmetry, symmetrical

Blob Art

INTRODUCTION: When you look into the mirror, you can see that your face looks almost the same on the left side as it does on the right side. We often say the face is symmetrical. When a shape is folded where two halves match, the shape is symmetrical. The line where the shape is folded is called the line of symmetry. In this activity you will make blob art and locate lines of symmetry.

PURPOSE:

- ✓ What makes a picture or drawing symmetrical?
- ✓ What is a line of symmetry?

MATERIALS:

construction paper	crayons
brush	scissors
paint (several colors)	magazines
pencil	tape, glue or paste

PROCEDURES:

1. Blob several different colors of paint on a sheet of construction paper. Make the blobs touch or overlap.
2. Fold the construction paper in half and press the folded paper flat.
3. Unfold the paper and look at the blob art picture you made. What do you see? ***Two half pictures that look alike.***
4. On the Response Sheet, make a drawing of the symmetrical figure you made. Make a line where the figure was folded.
5. Write several sentences on the Response Sheet that describe your symmetrical figure.
6. Look in a magazine and find a picture that you think shows symmetry. Cut the picture from the magazine. Fold it in the center, either "across" or "up and down". Does the picture have symmetry?

7. Find a picture you think does not show symmetry. Cut it from the magazine. Fold it in the center to check for symmetry.
8. When you find a picture that does not show symmetry, glue it on the Response Sheet.

OBSERVATIONS:

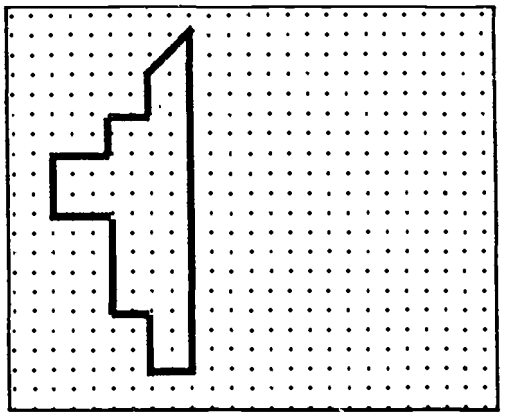
1. What did you see when you placed the blob of paint on the construction paper, folded it, and opened it? ***A picture that has two halves that mirror each other.***
2. How would you define a line of symmetry? ***A line that divides something in half, and both halves are exactly alike.***

CONCLUSIONS:

1. Do all shapes have a line of symmetry? Why or why not? ***No. Their halves do not look alike when folded.***
2. Can a shape have more than one line of symmetry? How do you know? ***Yes. Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Draw a straight line on a sheet of dot paper. Make a shape that touches the line on one side. Fold the paper along the line. Use a mirror to see a symmetrical image of your shape. Remove the mirror and try to draw the "mirror image" on the other side of the line of symmetry. Illustration 24-1 is an example.



24 - 1

- Investigate symmetry in a three-dimensional figure. Use clay to make a cube and a sphere. Use a plastic knife to cut the cube and the sphere into pieces that show symmetry.

Response Sheet
Blob Art

1. Picture of the blob art I made.

Pictures vary.

2. What I saw when I compared the halves of the blob art on each side of the fold line.

Answers vary.

3. Glue or paste one magazine picture that has symmetry and one that does not have symmetry.

Teacher's Guide
Exploring Interior Angles

GOAL: To have students explore ways to determine the sum of the measure of the interior angles of a triangle.

STUDENT OBJECTIVES:

- ✓ To investigate the interior angles of a triangle.
- ✓ To explore what happens when the interior angles of a triangle are combined.

GUIDE TO THE INVESTIGATION: Discuss with students and demonstrate interior angles of a triangle. Discuss and display polygons, parallelograms, and quadrilaterals. Demonstrate how to use a protractor.

Students need construction paper, pencil, paper, scissors, and tape to complete this exploration. This exploration can be carried out by individual students with the aid of an adult. Directions should be carefully read to students and demonstrated, particularly for younger students.

Students should follow these directions:

1. Draw a triangle on the construction paper.
2. Cut out the triangle.
3. Tear off the corners of the triangle.
4. Tape the corners side-by-side so each corner touches the same point.
5. Describe the shape that is made when the three corners are taped together.
6. What is the combined measure of the interior angles of the triangle?

Discuss the Observations and Conclusions.

VOCABULARY: interior, interior angle, protractor, parallelograms, corners, polygons, quadrilaterals

Exploring Interior Angles

INTRODUCTION: The combined measure of the three interior angles of a triangle is always the same. This is true whether the triangle is large or small. In this activity you will tear corners from large and small triangles and investigate to see if indeed they have the same measures.

PURPOSE:

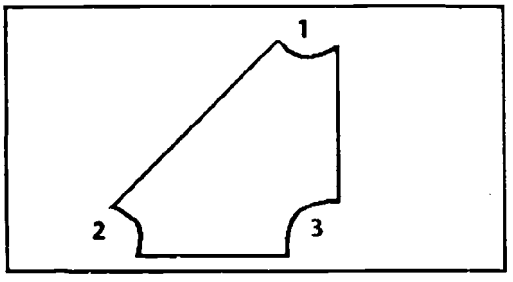
- ✓ What does interior mean?
- ✓ What are the interior angles of a triangle?
- ✓ What happens when the three interior angles of a triangle are combined?

MATERIALS:

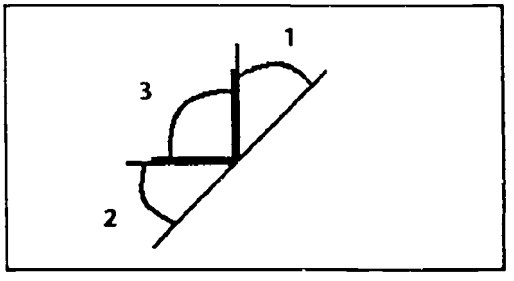
construction paper
pencil
paper
scissors
tape

PROCEDURES:

1. Draw a triangle on the construction paper.
2. Cut out the triangle.
3. Tear off the corners of the triangle.
4. Tape the corners side-by-side so that they each touch the same point, as shown in illustration 25–2.



25 - 1 *A triangle with the corners torn off*

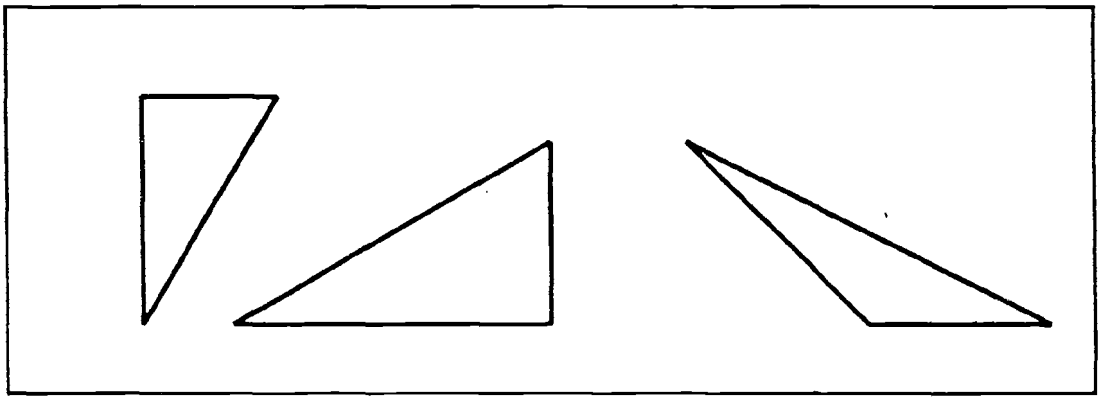


25 - 2 *Triangle corners rearranged*

5. Describe the shape that was made when you taped the three corners together with the corners touching. ***Answers vary.***

6. What is the measure of the interior angles of the triangle? How do you know? ***180°. Because the three corners taped together made a half-circle and a half-circle is 180°.***

7. Repeat this activity with a larger or smaller triangle and then with the triangles shown in illustration 25-3. Draw them on construction paper and cut them out.



25 - 3

OBSERVATIONS:

1. What shape was formed when you combined the three corners of the triangle? ***A half-circle.***

2. What is the measure of all three angles of a triangle? ***180°***

CONCLUSIONS:

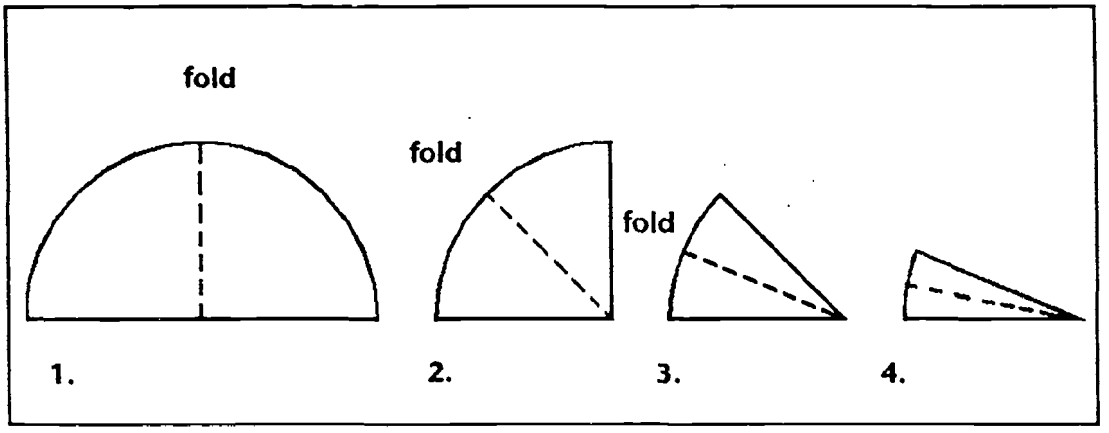
1. What happened when the three interior angles of the triangle were combined? ***They made a half-circle.***

2. What can you say about the measure of the interior angles of a triangle? ***The measure of the interior angles of a triangle is 180°.***

SUGGESTIONS FOR FURTHER STUDY:

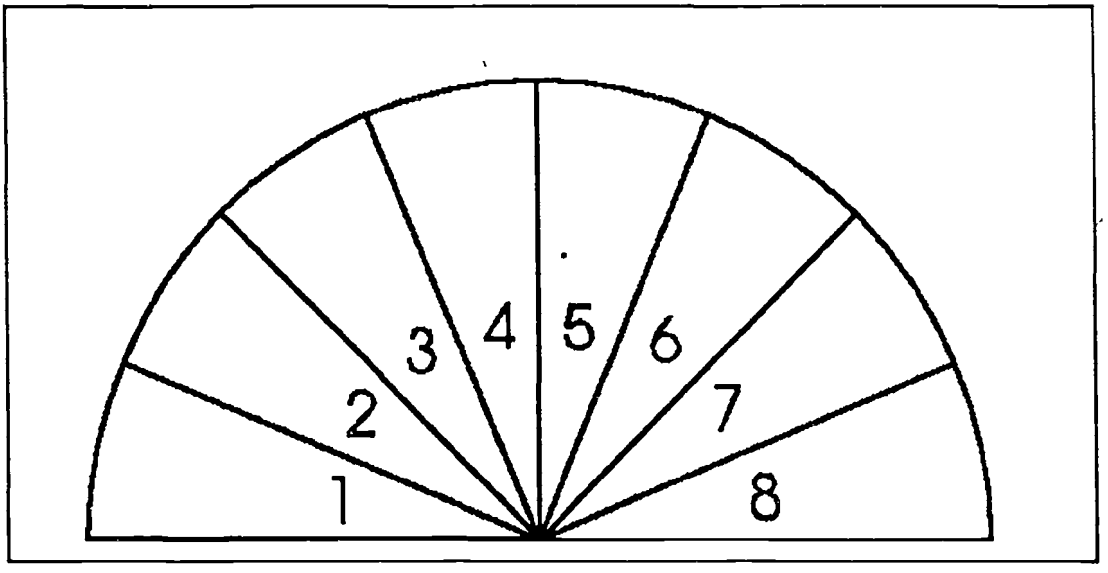
- Repeat this activity with a square, a rectangle, a quadrilateral with sides of four different lengths and a parallelogram other than a rectangle or square. What generalization can you make about the measure of the interior angles of these polygons? ***Answers vary.***

- Make a protractor from tag board or poster board. Cut a semicircle from the tag board or posterboard and another semicircle the same size from waxed paper. Fold the waxed paper in half. Then fold the waxed paper in half again.
  Fold the waxed paper a third time as shown in illustration 25-4. Open the waxed paper. Place the waxed paper over the tag board or posterboard. Trace along the folds onto the tag board or posterboard. Number the lines made by the folds on the protractor you have made.



25 - 5

This posterboard protractor shows you how a real protractor is divided so it can be used to measure angles.



25 - 4

Teacher's Guide
Compass Creation

GOAL: To have students investigate the parts of a circle - the center, the diameter, and the radius - through designs made with a compass.

STUDENT OBJECTIVES:

- ✓ To make designs with a compass.
- ✓ To identify the center, diameter, and radius of a circle.

GUIDE TO THE INVESTIGATION: Discuss the parts of a circle with students. Draw a circle on a transparency or on the chalkboard. Show students the circumference, center, the radius, and the diameter of a circle.

Students need a compass, a ruler, paper, pencil, and crayons to complete this investigation. This investigation can be completed by individuals. A demonstration of how to use a compass will be necessary for most students since this probably is their first experience with one.

Have students follow these directions:

1. Use a compass to draw a design that looks like the one in illustration 26-1.
2. Use a ruler to connect the points where the circles cross.
3. Draw the original design again. Use two different colors of crayons to color the design so that sections next to each other are not the same color.
4. Locate the center, the diameter, the circumference and the radius of one of the circles.

Discuss the Observations and Conclusions.

VOCABULARY: circle, circumference, center, diameter, radius, compass, line segments

Compass Creations

INTRODUCTION: Have you ever made a circle using a compass? Do you know the names of the parts of a circle? In this activity you will make designs using a compass. Then you will connect points in your design to help you identify parts of the circle.

PURPOSE:

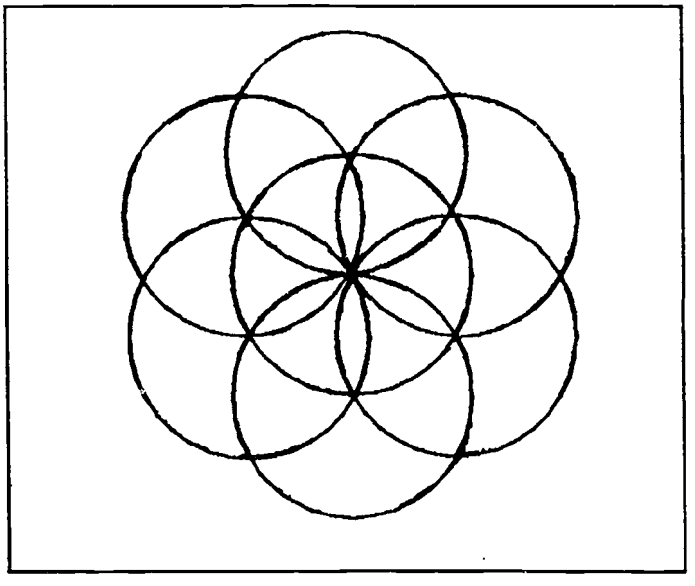
- ✓ How can you use a compass to make a design?
- ✓ What are the diameter, radius, circumference and center of a circle?

MATERIALS:

compass	paper
ruler	crayons

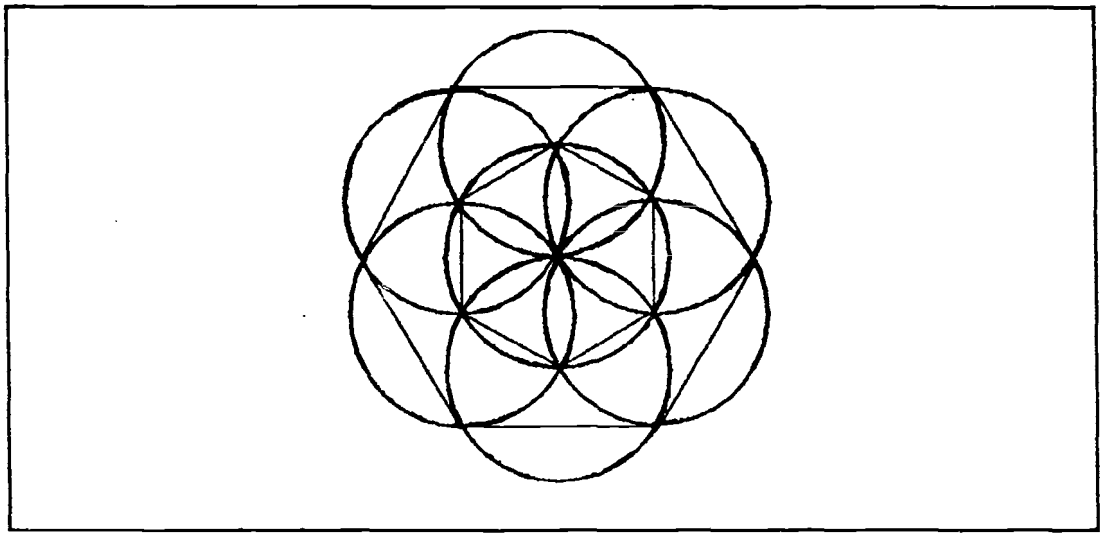
PROCEDURES:

1. Practice drawing circles with a compass.
2. When you can handle the compass, use it to draw a design like the one shown in illustration 26–1. Begin by making one circle on your paper. Place the point of the compass at any location on the circumference of the circle. Draw another circle on the circumference of the circle. Continue until you finish the design.



26 - 1

3. Use a ruler to connect the points of the "star" where the circles "cross" or intersect. (See illustration 26-2.)



26 - 2

4. Draw the original design again. Use two different colors of crayons to color the design so that sections next to each other are not the same color.

5. Locate the center, diameter, circumference, and radius of one of the circles.

OBSERVATIONS:

1. How many circles are in the original drawing? *7*

2. What shapes are formed by connecting the points on the outside of the circle where the circles "cross"? ***6 sided figures with sides of the same length.***

CONCLUSIONS:

1. Where are the centers of each of the circles that are connected to the middle circle? ***On the circumference of the circle.***

2. If you continued drawing circles could you connect points where circles intersect and form squares? Why or why not? ***No. Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Use the compass and pencil to construct a circle with a radius of 3 inches. Spread the compass points to 3 inches. Use the center of the circle as one vertex. Use a ruler or other straight edge to make a square. What is the measure of each side of the square? Is another side of the square the length of the radius of the circle? Make a drawing that proves your answer. ***3 inches. Yes.***
- Use a compass and a ruler to construct a triangle. Experiment with the compass and ruler to find a way to construct a triangle. Once you have figured out a way to draw the triangle using the compass, explain to another student what you did.

Teacher's Guide
Mosaic

GOAL: To have students explore creating mosaic patterns and to be informally introduced to coordinate planes.

STUDENT OBJECTIVES:

- ✓ To create a mosaic design on a coordinate plane.
- ✓ To explore "flipping" designs.

GUIDE TO THE INVESTIGATION: Gather students around a table. Place a drop of ink near a center fold on a piece of white paper. Fold the paper over to make an ink blot. Allow student to discuss the design and discover that the ink blot is identical on each side of the fold. Show pictures and define: axis, flip, horizontal, vertical.

Students need grid paper (included) and colored pens or pencils for this activity.

This activity can be completed by individual students with the assistance of an adult. Older students may complete the patterns in pairs.

Have students follow these directions:

1. Make a mosaic design to the right of the vertical axis on a piece of grid paper. Use several colored pencils or pens to color in squares to make the design.
2. To the left of the vertical axis, make a design that is a "flipped" version of the design to the right of the vertical axis.
3. Check by folding, to make sure the sides of your design are identical, like the ink blots.
4. When students complete their mosaic designs, have them share the designs with members of the class. Display the designs on a bulletin board.

Discuss the Observation and Conclusions questions in a total class discussion.

VOCABULARY: coordinate plane, axis, mosaic, flip, congruent, horizontal, vertical

Mosaic

INTRODUCTION: Mosaic art is usually two-dimensional and can be created on a plane surface. In this activity you will use graph paper as a "canvas" to create mosaic patterns.

PURPOSE:

- ✓ What is a flip?
- ✓ How can a mosaic pattern be created using a coordinate plane?
- ✓ What happens when a pattern is "flipped"?

MATERIALS:

graph paper
colored pens or pencils

PROCEDURES:

1. Study the example of mosaic art on the Response Sheet.
2. Draw a mosaic design to the right of the vertical axis on the grid paper. Your design may be above and below the horizontal axis.
3. Once you have made the right side of the design, repeat the design on the left side of the vertical axis. The design on the left should look exactly like the design on the right, but it has been flipped.
4. Fold the design along the vertical axis. Hold it up to the window or toward the light. Does the left side of the mosaic fit exactly on the right side of the mosaic? When one design fits exactly on the other, the designs are congruent.

OBSERVATIONS:

1. What colors did you use for your mosaic? ***Answers vary.***
2. Does the right half of your design fit exactly on top of the left half of the design? ***Yes, if it is drawn correctly.***

3. If the sides do not exactly match, what should you have done to make them match? ***Answers vary.***

CONCLUSIONS:

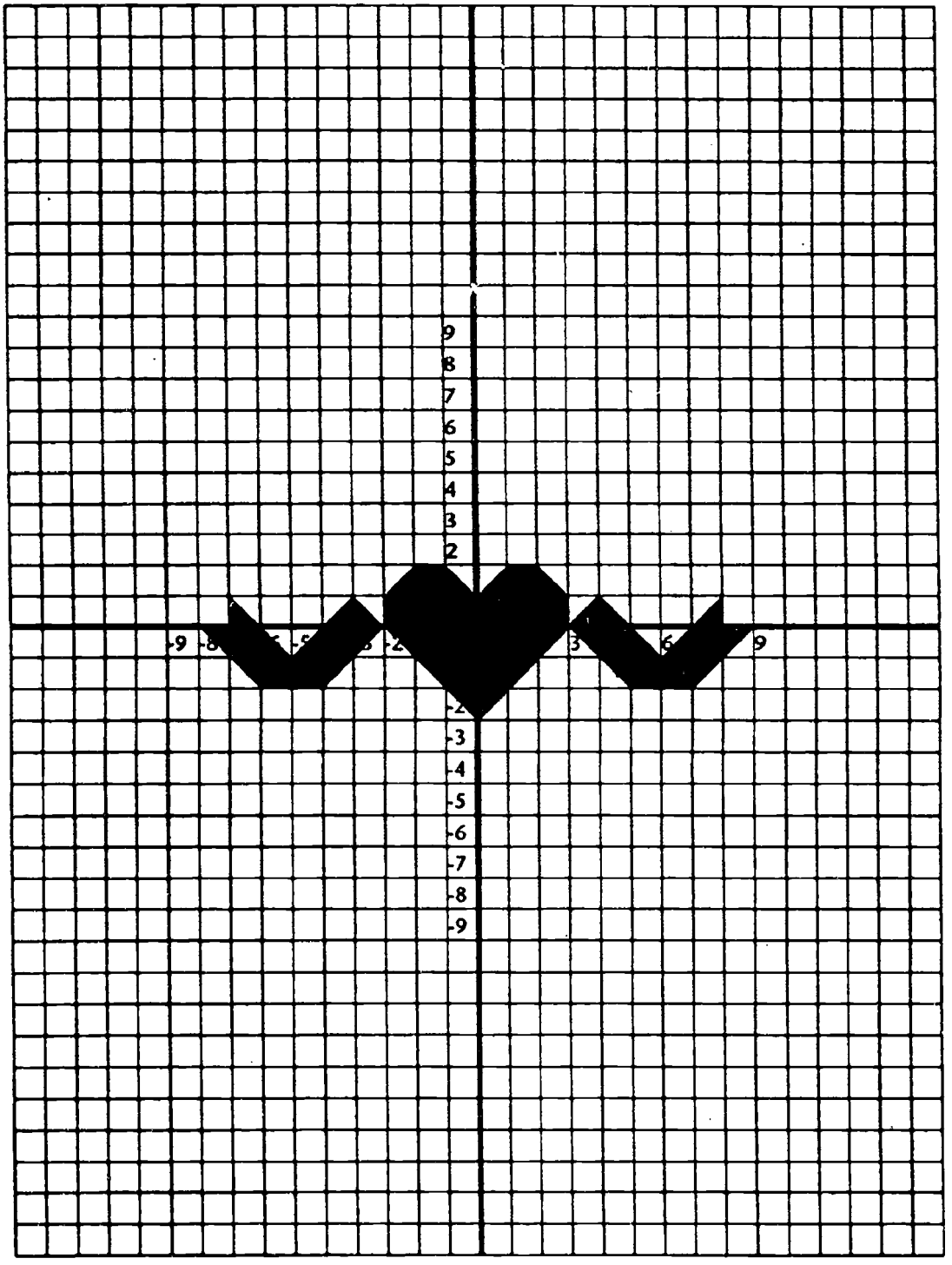
1. How many dimensions does your mosaic have? ***2***
2. How can color be used to give the mosaic pattern a three-dimensional appearance? ***Answers vary.***
3. What generalization can you make about a "flipped" figure? ***The flipped figure looks exactly like the original figure.***

SUGGESTIONS FOR FURTHER STUDY:

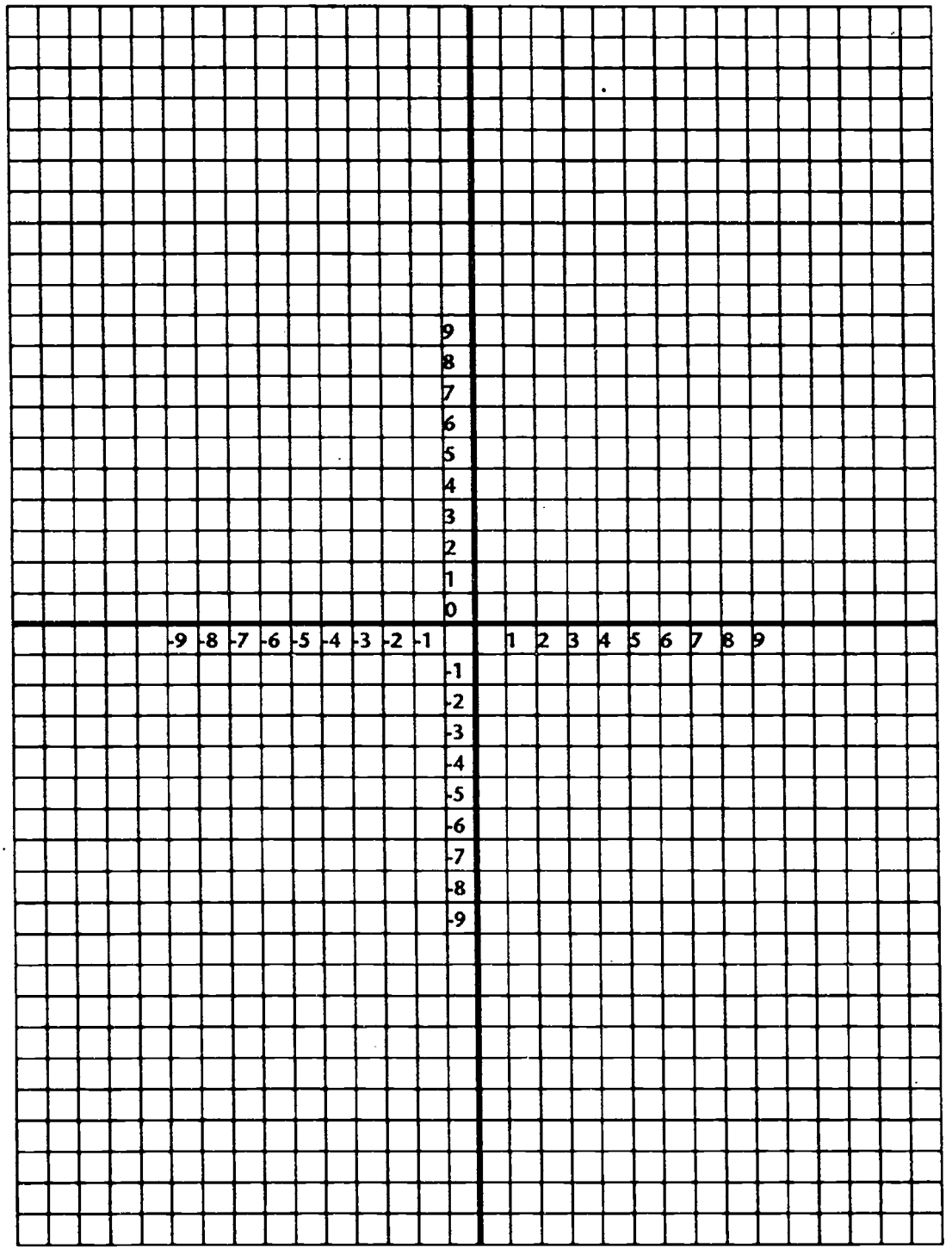
- Experiment with different types of media to create varying textures for mosaic designs. For example, needle pointing is an art form that uses some of the techniques investigated in this activity.
- Look in some art books in your school or public library. Find some examples of mosaic art like the ones you made in this activity. Share the designs in class.
- Look through wallpaper books or samples of floor tile. Find examples of mosaic designs. Draw one or more of the designs you find. Make a frame for your design from posterboard. Hang your design in your bedroom or any room at home.

Response Sheet
Mosaic

An example of Mosaic Art



Create your own mosaic on the grid paper.



Teacher's Guide
Stitched Design

GOAL: To have students explore how the arrangement of straight lines can give the appearance of curved designs.

STUDENT OBJECTIVES:

- ✓ To measure and follow directions.
- ✓ To make curved designs.

GUIDE TO THE INVESTIGATION: Discuss straight lines, angles, and curves. Have students give examples of each.

Students need lightweight cardboard or poster board, ruler, pencil, large needle, heavy thread or lightweight yarn, and tape.

This activity can be completed by individual students with the guidance of an adult. Older students can work together to make the stitched design.

Have students follow these directions:

1. Draw an angle on the back of the cardboard.
2. On each side of the angle, mark 1 centimeter segments.
3. Use your needle to carefully punch holes at each mark.
4. Label the marks 1 through 8 and A through H as shown.
5. Thread the needle with a piece of thread about an arm's length.
6. Starting on the back side of the cardboard, pull the thread almost through the first hole.
7. Tape the end of the thread in place on the back side.
8. Stitch from hole to hole in this order: A to 1; to 2; to B; to C; to 3; to 4; to D; to E; to 5; to 6; to F; to G; to 7; to 8; to H. (If you run out of thread, tape the end of the old thread on the back and start a new thread.)

Discuss the Observations and Conclusions after students have completed their designs.

VOCABULARY: curves, straight lines, angle

Stitched Design

INTRODUCTION: Designs that look like curves can be made from straight lines. In this activity you will explore measuring, counting, following directions, and making a curved design using only straight lines.

PURPOSE:

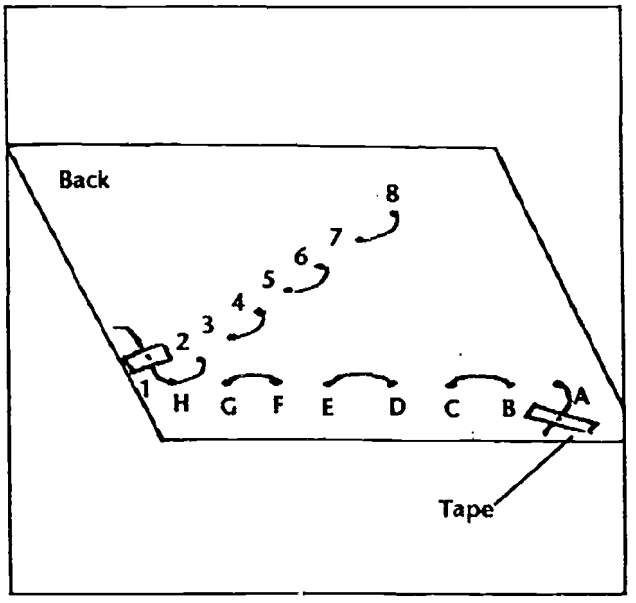
- ✓ How can straight lines be used to make curved designs?
- ✓ Why is it important to measure carefully and follow directions to complete this exploration?

MATERIALS:

lightweight cardboard or poster board
heavy thread or lightweight yarn
tape
centimeter ruler
pencil
large needle

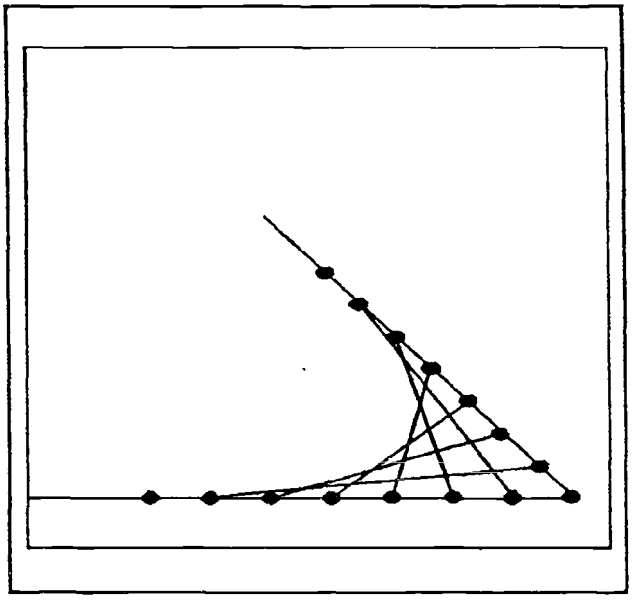
PROCEDURES:

1. Draw an angle on the back of the cardboard.
2. On each side of the angle, mark 1 centimeter segments.
3. Use a needle to carefully punch holes at each mark.
4. Label the marks 1 through 8 and A through H as shown in illustration 28-1. (Marks 1 and H are the same location.)



28 - 1

5. Thread the needle with a piece of thread about the length of your arm.
6. Pull the thread almost through hole A starting on the back side of the cardboard.
7. Tape the end of the thread in place on the back side of the cardboard.
8. Stitch from hole to hole in this order:
   A to 1; to 2; to B; to C; to 3; to 4; to D; to E; to 5; to 6; to F; to G; to 7; to 8; to H.
   (If you run out of thread, tape the end of the old thread on the back of the cardboard and start a new thread.)
   Your stitching should look like that in illustration 28-2.



28 - 2

OBSERVATIONS:

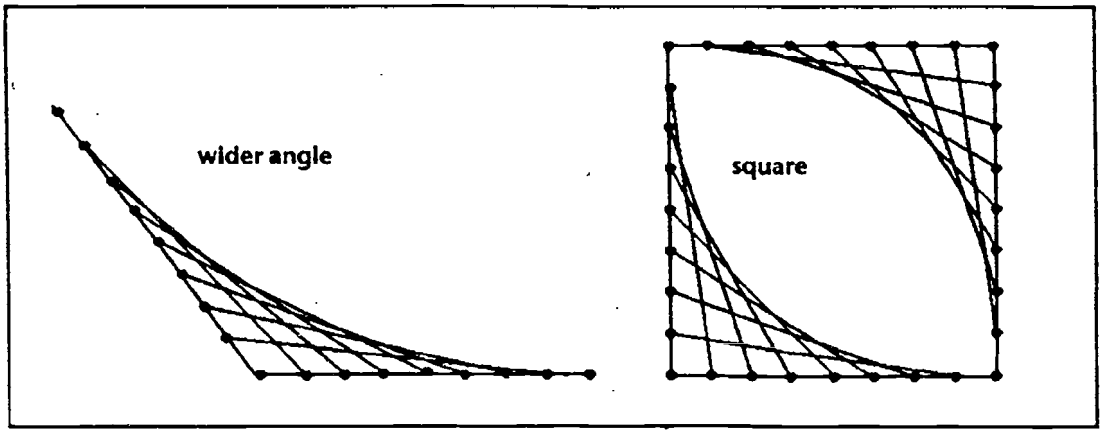
1. Did your straight lines appear to make curves? ***Yes.***
2. Where have you seen designs similar to the ones you made? ***Answers vary.***

CONCLUSIONS:

1. What would happen to the design if you did not measure carefully and follow the directions exactly? ***The straight lines may not look curved.***
2. Why do straight lines appear to be curved? ***Answers vary. Possible answer may be because they cross.***

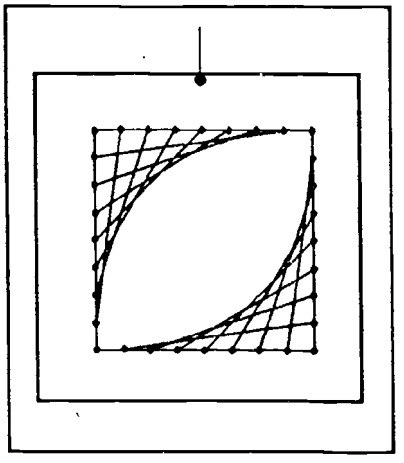
SUGGESTIONS FOR FURTHER STUDY:

- On a piece of cardboard draw a wider angle. Follow the same directions to make a thread design.



28 - 3

- Try drawing a square and stitching a design on two of its angles.
- Make other designs using angles and stitching on paper. Use different colors of thread and angles of different shapes. If possible, leave off numbers and letters. Display your work by making two designs on the same size paper. After completing the two designs, glue the papers together back to back. Hang your design as a mobile.



28 - 4

Teacher's Guide
Making A Tetrahedron

GOAL: To have students investigate combining two-dimensional shapes (triangles) to make a tetrahedron.

STUDENT OBJECTIVES:

- ✓ To build a tetrahedron mobile.
- ✓ To find the number of faces on a tetrahedron.

GUIDE TO THE INVESTIGATION: Discuss pyramid, base, congruent, and tetrahedron. Show models or illustrations of each. Ask students to tell where they have seen real world things that are pyramids or tetrahedrons.

Students need six straws and string or yarn to complete this investigation. This activity can be completed by individuals with the guidance of an adult. To thread the yarn or string through the straws more easily, fasten a small safety pin to the end of the yarn or string.

Have students follow these directions:

1. Connect 3 straws together with string to make a triangle.
2. Use 2 more straws and string to make the figure shown in illustration 29-2.
3. Use 2 more straws and string (as shown in illustration 29-3) to complete the tetrahedron. Discuss the number of faces on the tetrahedron.

Discuss the Observations and Conclusions.

VOCABULARY: pyramid, base, face, tetrahedron, congruent, equilateral

Making A Tetrahedron

INTRODUCTION: Many two-dimensional shapes can be combined to make three-dimensional shapes. For example, six squares can be taped together to make a cube. In this activity you will combine shapes to make a tetrahedron.

PURPOSE:

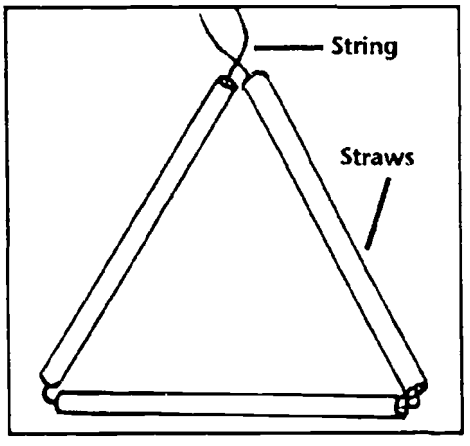
- ✓ How can a tetrahedron mobile be made?
- ✓ How many faces does a tetrahedron have?

MATERIALS:

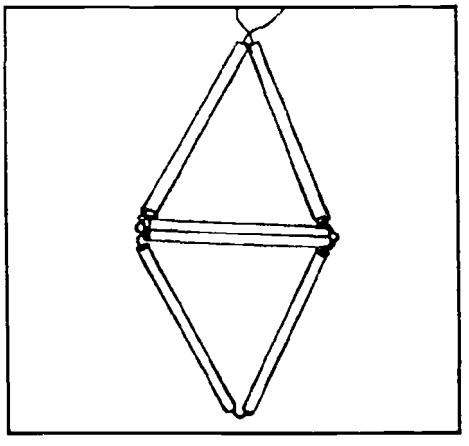
6 straws
string or yarn
scissors
small safety pins

PROCEDURES:

1. String three straws together to make a triangle. Thread the string through the straws as in illustration 29-1
2. Use two more straws, string, and the original triangle to make another triangle as in illustration 29-2. Thread the string as shown.

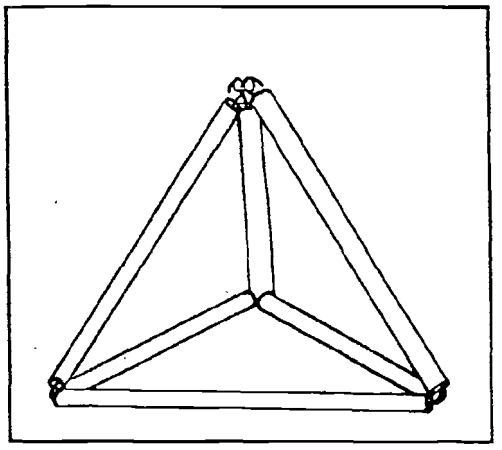


29 - 1



29 - 2

3. Pull the lower triangle up. String another straw as shown below. Thread the four strings through the straw. Then put the 6th straw onto the string and pull the ends of the string to the top. Tie the string into a bow or knot as in illustration 29-3.
4. How many faces does the tetrahedron have? *4*



29 - 3

OBSERVATIONS:

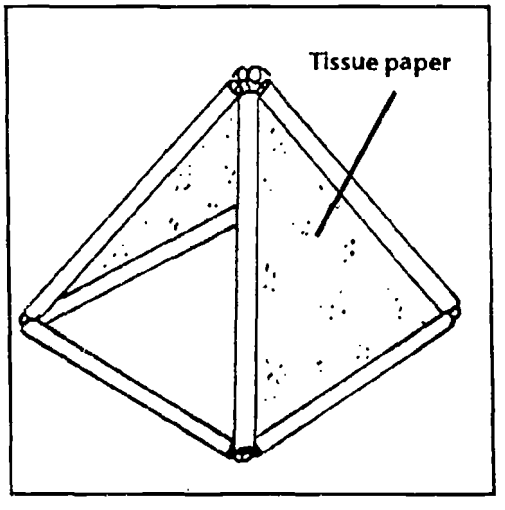
1. How many faces are there on a tetrahedron? *4*
2. What things can you name that are tetrahedrons? ***Answers vary.***

CONCLUSIONS:

1. How many triangles are faces of a tetrahedron? *4*
2. If the number of triangles were more or less, would your mobile still be a tetrahedron? ***It depends on the number of triangles more or less. If 2 or more are added, it is still a tetrahedron.***
3. What are other characteristics of a tetrahedron? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Make a kite from the tetrahedron. Cover two of the faces with tissue paper or waxed paper; attach a new string to the kite to enable it to fly. Where will you need to attach the string so that air will flow through the two uncovered sides and push the kite into the air? ***On opposite sides.***



29 - 4

- Use straws and string to make other mobiles. What shapes can you make from the straws and string? How can these shapes be put together to form 3-dimensional shapes? ***Answers vary. The shapes can be put together just as the triangles were.***

ESTIMATION

Teacher's Guide
Time Is Dripping Away!

GOAL: To have students gain an understanding of ways people long ago used water clocks to tell time.

STUDENT OBJECTIVES:

- ✓ To make a water clock.
- ✓ To estimate time.
- ✓ To use a water clock to time activities.

GUIDE TO THE INVESTIGATION: Have students discuss clocks, watches and other ways they know to measure time. Ask if anyone has ever seen a sun dial or a sand timer.

Students need a clean, empty gallon milk jug, scissors with sharp points, masking tape, a ball-point pen, and a pencil.

This activity can be completed by pairs of students with the guidance of an adult or older student.

Direct students to:

1. Cut a small hole near the bottom of the milk jug.
2. Cover the hole with masking tape.
3. Place a strip of masking tape down the length of the jug.
4. Fill the jug with water. Remove the tape from the hole while holding the jug over a sink. Count one thousand one, etc. Mark on the tape when you count 10, 20, 30,... seconds to make the water clock.
5. Then have students complete the activities on the Response Sheet.

Discuss the Observations and Conclusions.

VOCABULARY: water clock, gauge, estimate, predict

Time Is Dripping Away!

INTRODUCTION: Long ago, people told time with water clocks. Water dripped slowly from a container, and a gauge on the container showed how much time had passed. In this investigation you will make a water clock and use it to measure how much time has passed. You will explore estimating time.

PURPOSE:

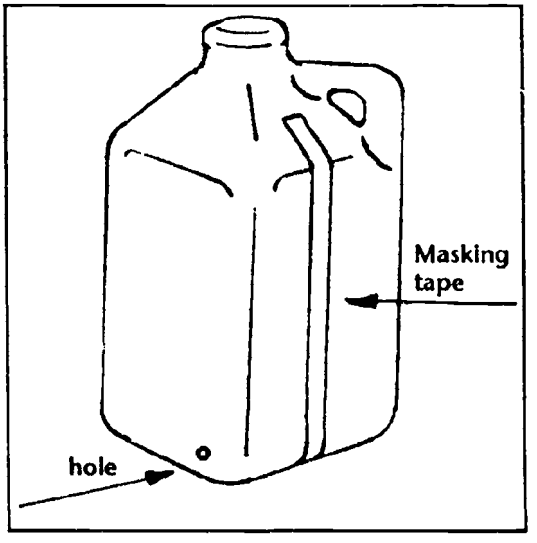
- ✓ What is a water clock?
- ✓ How do you use a water clock to time activities?
- ✓ How can you estimate the passage of time?

MATERIALS:

a clean, empty gallon milk jug
scissors with sharp points
masking tape
ball-point pen
pencil

PROCEDURES:

1. Cut a small hole near the bottom of a milk jug. The hole should be about the size of the letter "n" in this sentence.
2. Put masking tape over the hole.
3. Place a strip of masking tape down the entire length of the jug as shown in illustration 30-1.
4. Work over a bathtub or sink. Keeping your finger over the taped hole, fill the jug with water.
5. Get ready to mark on the tape strip as soon as you uncover the hole.



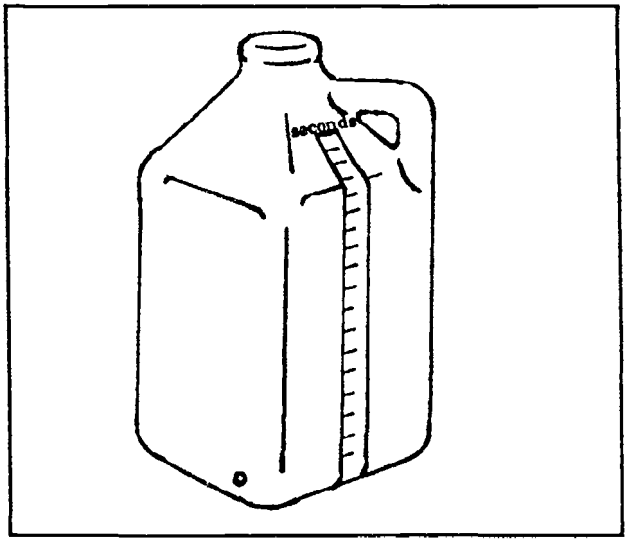
30 - 1

6. Place the jug in the bathtub or sink. Let go of the hole and remove the tape.

7. Count "one thousand one, one thousand two, one thousand three,..." and so on as the water flows out. Each count is approximately one second. Keep counting as long as it takes all the water to flow out.

8. Using a pencil or marker have your partner make a mark on the tape strip as you reach 10, 20, 30, 40, 50 seconds and so on. (You will probably be able to count to between 80 and 120.)

9. Repeat the steps. This time have your partner use a ball-point pen to make the marks in ink.



30 - 2

10. Number the marks on the tape starting at the top with 10. Write "seconds" near the top of the tape to show that the marks are for seconds.

11. With your partner, try to complete these activities before the water runs out of the water clock. Before you begin each one, predict whether or not you will be able to finish before the jug is empty

    a. Wash and dry your hands.

    b. Clean your desk.

    c. Erase the chalkboard.

    Ring yes or no on the Response Sheet to show your prediction.

12. List 5 or more things to do before the water runs from the water clock. Estimate your times. Test each thing. How close were your estimates?

OBSERVATIONS:

1. Which activities did you complete before all the water ran from the water clock? ***Answers vary.***
2. Were you better at predicting the yes or no activities or the activities where you estimated the time it would take to do things? ***Answers vary.***

CONCLUSIONS:

1. Is the water clock an accurate way to measure the passage of time? ***No.***
2. Why did you answer the way you did? ***Answers vary.***
3. How can you make your water clock more accurate? ***Answers vary.***
   Possible answers may suggest repeating the counting and marking step of the procedure several times to improve accuracy.

SUGGESTIONS FOR FURTHER STUDY:

- Guess how long it will take to make a sandwich or brush your teeth. Take the water clock home and time these activities.
- Take your water clock outdoors. Time yourself. Can you do 15 jumping jacks before your clock runs out of water?
- Read about other ways people told time long ago. Draw pictures of other ancient clocks that people used and put the pictures on a poster. Share the poster with your class.

Response Sheet
Time Is Dripping Away!

I can do these things before the water completely runs out of the water clock. Ring yes or no.		
1. Wash and dry my hands.	Yes	No
2. Clean my desk.	Yes	No
3. Erase the chalkboard.	Yes	No

Answers vary.

Things I can do.	Estimated Time	Actual Time
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Teacher's Guide
Rectangular Circles

GOAL: To have students investigate finding the area of a circle by changing the circle into a rectangular region.

STUDENT OBJECTIVES:

- ✓ To explore the area of a circle.
- ✓ To compare the area of a circle to that of a rectangle made from a circle.

GUIDE TO THE INVESTIGATION: Discuss area, the amount of space covered on a surface, with students. Be sure students understand that there are formulas for finding the areas of different figures and that formulas make it easier to find area.

Students need a ruler, a compass, scissors, pencil, construction paper, tape or glue, and a calculator to complete this investigation.

This investigation can be carried out by individual students with the aid of an adult or by groups of students, again with the aid of an adult.

Have students follow these directions:

1. Use a compass. Draw a circle with a radius of 2 inches on construction paper.
2. Use a pencil and a ruler to divide the circle into 8 or 12 equal sized wedges.
3. Use scissors to cut the wedges apart.
4. Lay the wedges on another sheet of construction paper as shown in illustration 31-2. Tape or glue the wedges down.
5. Use a ruler to measure the length and width of the rectangular region covered by the wedges. Multiply the length by the width of the "rectangle"to obtain the area.
6. Use the formula $A = \pi r^2$ to find the area of the circle. Are the two areas - the rectangular region and the circle - about the same?
7. Repeat the activity using larger and smaller circles. Are the results the same?

Discuss the Observations and Conclusions.

VOCABULARY: approximate, formula, radius, length, width, area

Rectangular Circles

INTRODUCTION: Area is the space covered on a surface. You need to know the area of a floor when you buy carpet or floor covering. It is more difficult to find the area of an object that is circular or curved. In this activity you will turn a circle into a rectangular region and find the area of the rectangular region.

PURPOSE:

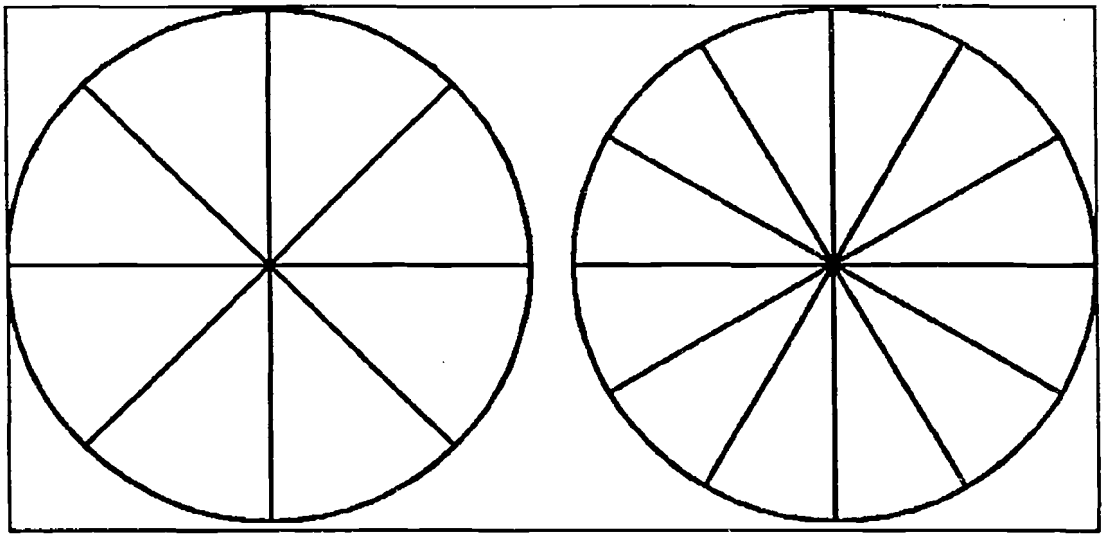
- ✓ How can you find the area of a circle without using a formula?
- ✓ How is the area of a circle similar to the area of a rectangle?

MATERIALS:

ruler
compass
scissors
pencil
construction paper
tape or glue
calculator

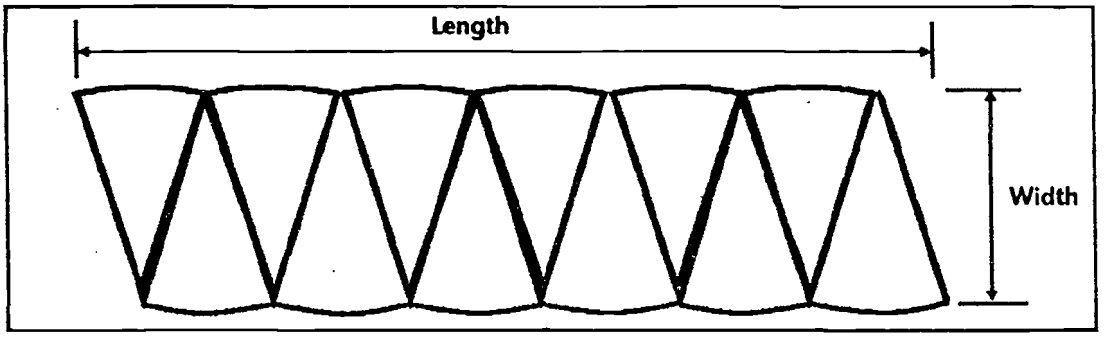
PROCEDURES:

1. Use a compass. Draw a circle with a radius of 2 inches (a diameter of 4 inches) on construction paper.



31 - 1

2. Use a pencil and a straight edge to divide the circle into 8 or 12 equal-sized, wedges as shown in illustration 31-1.
3. Use scissors to cut the wedges apart.
4. Lay the wedges on a sheet of construction paper as shown in illustration 31-2.
   Tape or glue the pieces together.



31 - 2

5. Use a ruler to measure the length and width of the rectangular region you made from the wedges.
6. Multiply the length of the region by its width. What is the approximate area of the rectangular region? *Answer depends on the size of the circle that was drawn.*
7. Use the formula $A = \pi r^2$ and a calculator to find the actual area of the circle. π is approximately 3.14. Area = $3.14 \times (2)^2$. Multiply 4 x 3.1 4. Is this area about the same as the area you obtained for the rectangular region? *It should be.*
8. Repeat this activity using larger and smaller circles cut from the construction paper.

OBSERVATIONS:

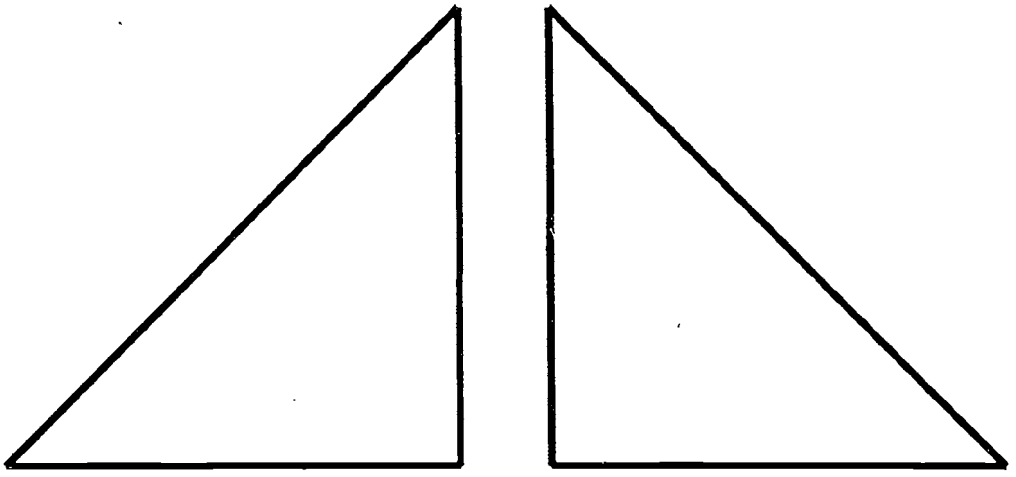
1. Was the area of the rectangular region and the area of the circle about the same? *Yes.*
2. Does this procedure work with larger and smaller circles? *Yes.*

CONCLUSIONS:

1. How is the area of a circle similar to the area of a "rectangle" made from the circle? ***They are about equal.***
2. What is area? ***The space covered.***
3. What are some times when you need to find area? ***Answers vary.***
4. Why is it easier to use a formula to find the area of a circle than the method we used? ***It is faster and more accurate.***

SUGGESTIONS FOR FURTHER STUDY:

- Draw 2 triangles like the ones shown.



  Cut them out. Turn them around and place them together so they make a rectangle. Find the area of the rectangle by multiplying the length by the width. How can you figure out what the area of the triangle is?

- Use a geoboard and rubber bands. Make squares, rectangles, and triangles of different sizes on the geoboard. Count the number of small squares inside the rubber bands to find the area of the squares and rectangles. What can you do to find the area of the triangles?

Teacher's Guide
Weighing Pints

GOAL: To have students explore weighing the same size containers filled with different materials and to gain an understanding of estimation of weights.

STUDENT OBJECTIVES:

- ✓ To weigh pint containers filled with different materials.
- ✓ To estimate the weight of various materials.

GUIDE TO THE INVESTIGATION: Discuss with students that you cannot always estimate or judge the weight of an object by its size. Demonstrate by using a solid brass weight (approximately 500 g) and a small plastic container filled with flour. (Weight and container should be about the same size.)

Students need two plastic pint containers, a balance scale, several 1, 5, 10, 50, 100 and 500 gram weights, a pint or more of each of these materials: water, rice, pebbles, cereal, flour, toothpicks, and wooden or plastic beads.

This activity should be carried out by groups of 3 or 4 students. Introduce the concept of weights and demonstrate how to use the balance and weights. Students can complete the explorations in groups. Younger students may need help reading and recording on the chart.

Have students follow these directions:

1. Fill a pint container with water. Estimate the weight of the pint of water. Record your estimate on the chart on the Response Sheet. Place the pint of water on one side of the balance. Place weights on the other side of the balance scale until you get a balance. Record the weight of the water on the chart on the Response Sheet.
2. Next fill the other pint container with rice. Estimate the weight of the rice and record your estimate. Place the container of water on one side of the balance and the container of rice on the other side of the balance. Do they weigh the same? Next remove the container of water from the balance. Place weights on the balance until you find the weight of the pint of rice. Record the weight on the chart.
3. Repeat with the cereal, pebbles, beans, flour, sugar, toothpicks, and beads. Estimate and then make a balance. Record the estimates and the weights on the chart on the Response Sheet.

4. Answer the questions below the chart.
Discuss the Observations and Conclusions.

VOCABULARY: balance scale, pint

Weighing Pints

INTRODUCTION: Often estimating the weight of an object is not easy to do. Looks can be deceiving. Sometimes objects or materials look as though they are light when they are really heavy. In this activity you will fill a pint container with several different materials and weigh the containers on a balance scale. You will use the weightings to help you estimate the weight of other materials.

PURPOSE:

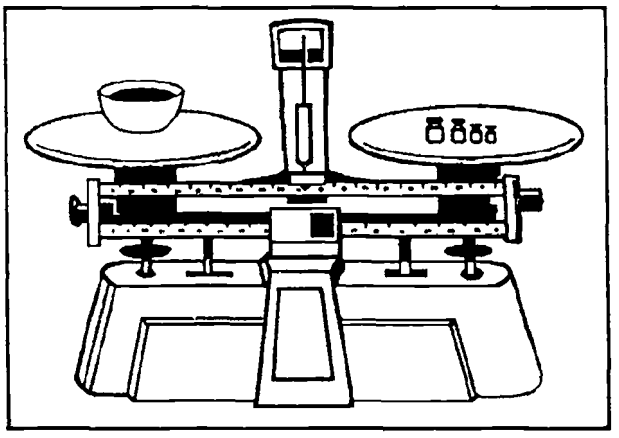
- ✓ Which weighs more, a pint of water or a pint of rice?
- ✓ What things can I do to help me become better at estimating weights?

MATERIALS:

a balance scale
2 one pint plastic containers
several 1, 5, 10, 50, 100 and 500 gram weights
a pint or more of each of the following:
water, rice, pebbles, cereal, beans, flour, sugar, toothpicks, wooden or plastic beads

PROCEDURES:

1. Fill the pint container with water. Estimate and record the weight of the water in grams. Place the container filled with water on one side of the balance. Make the sides of the scale balance by placing weights on the other side of the balance. Record the weight of the water on the chart on the Response Sheet.



32 - 1

2. Next fill the other pint container with rice. Estimate the weight of the rice. Record your estimate on the chart. Then place the container of rice on the balance. Place the pint container filled with water on the other side of the balance. Do they weigh the same? Remove the container of water. Place the weights on the balance until you obtain a balance. Record the weight on the chart.
3. Repeat the procedure with the cereal, pebbles, beans, flour, sugar, toothpicks, and beads. Estimate and then make a balance. Record your estimates and weights on the chart on the Response Sheet.
4. Answer the questions below the chart.

OBSERVATIONS:

1. Which of the materials weighs the most? ***Pebbles.***
2. Which of the materials weigh the same? ***Answers vary according to the kind of cereal and the material of which the beads are made..***

CONCLUSIONS:

1. Why is it difficult to look at various materials and estimate their weight? ***Answers vary.***
2. What are some things you can do to help yourself become better at estimating the weight of different objects? ***Practice estimating and weighing.***

SUGGESTIONS FOR FURTHER STUDY:

- Get several cans of soup or vegetables. Be sure the cans are the same size. Read the labels of the cans to find which weighs more. Are the weights of the cans the same? ***Yes.***
- Make a chart that lists all members of your family or members of your class. Estimate the weight of one person on the list and write the estimate on the chart. Then use bathroom scales to find that person's actual weight. Record the actual weight on your chart. Then estimate the weight of the next member of your class or family. Record the estimate and use scales to find that person's actual weight. Was your estimate better with the

second person? Continue estimating and weighing the people one at a time. Does your power of estimating become better?

Response Sheet
Weighing Pints

One Pint of:	Estimate	Weight
water		
rice		
cereal		
pebbles		
beans		
flour		
sugar		
toothpicks		
wooden or plastic beads		

Which weighs more, the water or the rice? *Water*

Which weighs less, the flour or the beans? *Flour*

Which weighs the most? *Pebbles*

Which weighs the least? *Cereal*

Teacher's Guide
Probability Roll

GOAL: To have students investigate probability and make predictions.

STUDENT OBJECTIVES:

- ✓ To perform an experiment in probability.
- ✓ To predict the outcome of an experiment.

GUIDE TO THE INVESTIGATION: Discuss the weather forecasts that are shown on the nightly news on television. Ask students if they know what a prediction is and how a person makes a prediction.

Each pair of students needs a cardboard roll from bathroom tissue, and one from paper towels or aluminum foil, rulers, scissors, paper, and pencil to complete this exploration.

Students should work in pairs to complete the investigation. They may need help in measuring and cutting the rolls. Once directions are given and demonstrated, students should be able to complete the activity on their own.

Demonstrate the dropping of the cardboard rolls on the floor. Explain what is meant by landing on the end and landing on the side.

Have students follow these directions:

1. Measure the length of the bathroom tissue rolls. Record the length on the Response Sheet.
2. Drop the roll to the floor 20 times from the same height each time. Count and record the number of times the roll lands on its end and the number of times it lands on its side.
3. Repeat the same procedure using the roll from the paper towels or the aluminum foil. Record your results on the Response Sheet.
4. Cut one inch from one end of the paper towel roll. Repeat the same procedure with the roll that is one inch shorter. Record the results on the Response Sheet.
5. Cut another inch from the paper towel roll. Repeat the same procedure. Record the results on the Response Sheet.
6. Continue cutting one inch from the roll, dropping the roll 20 times and recording the results on the Response Sheet until you cannot cut another inch from the roll.

Discuss the Observations and Conclusions.

VOCABULARY: probability, predict, possible, impossible, likely, unlikely

Probability Roll

INTRODUCTION: We often hear people say that something is possible or impossible or is likely to happen or unlikely to happen. When we are positive something will happen we say it is certain, but when an event cannot happen it is impossible. In this activity, you will perform an experiment to find whether a cardboard roll is more likely to land on its end or its side when dropped to the floor.

PURPOSE:

- ✓ What is probability?
- ✓ How can predictions be made?

MATERIALS:

cardboard roll from bathroom tissue and from paper towels or aluminum foil
pencil
paper
ruler
scissors

PROCEDURES:

1. Use a ruler to measure the length of the bathroom tissue roll. Record the length on the Response Sheet.
2. Drop the roll to the floor 20 times from the same height each time. Count and record the number of times the roll lands on its end and the number of times it lands on its side.
3. Repeat the same procedure using the roll from the paper towels or aluminum foil. Record your results on the Response Sheet.
4. Cut one inch from the end of the paper towel roll. Repeat the same procedure with this shorter roll. Record the results on the Response Sheet.

5. Continue cutting one inch from the roll, dropping the roll 20 times, and recording the results on the Response Sheet until you cannot cut another inch from the roll.

OBSERVATIONS:

1. How many times did the bathroom tissue roll land on its end and how many times on its side? ***Answers vary.***
2. How many times did the paper towel roll land on its end and how many times did it land on its side? ***Answers vary.***

CONCLUSIONS:

1. Did either of the rolls land on its end every time you dropped it? If so what was the length of the roll? ***Unlikely.***
2. Would it matter if the roll were "fatter" or "thinner"? ***Answers vary.***
3. How can you find the length of a roll that will land half the time on its end? ***You would have to repeat the investigation many, many times.***

SUGGESTIONS FOR FURTHER STUDY:

- Work with a partner. Flip a penny to see if it lands heads up or tails up. Make a tally of the number of heads and the number of tails in 10 flips. Then have your partner flip the penny 10 times and make a tally of the number of heads and number of tails. Discuss how the number of heads and tails were alike or different. Predict the number of heads and tails for 50 flips of the penny. Flip the penny 50 times and record the heads and tails. Were you correct? Predict the number of heads and tails for 100 flips. Flip the penny 50 more times. Add the heads and tails for the 100 flips. What did you find out?

Response Sheet
Probability Roll

Length of cardboard roll	Number of times landed on end in 20 drops	Number of times landed on side in 20 drops
1.		
2.		
3.	*Answers vary.*	
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Teacher's Guide
What Is Your Surface Area?

GOAL: To have students explore surface area and gain an understanding of the meaning of surface area.

STUDENT OBJECTIVES:

- ✓ To find the approximate surface area of one's body (area of skin).
- ✓ To investigate how to make generalizations from collected data.

GUIDE TO THE INVESTIGATION: Discuss the concept of surface area, using as an example the fact that when the walls of a room are painted, the paint covers the surface area. Explain that the skin covers the surface area of the body.

Students need centimeter grid paper (included) and a pencil or crayon to complete this exploration. This activity can be completed by individuals or small groups of students under the guidance of an adult.

Students should follow these directions:

1. Place your hand on the centimeter grid paper.
2. With the pencil or crayon, trace an outline of your hand on the grid paper.
3. Make a check in each square inside the drawing of the hand, as shown in illustration 34–1. Make the check even if only part of the square is inside the outline.
4. Count the checks. Multiply the number by 100.

Discuss the Observations and Conclusions.

VOCABULARY: closed region, area, surface area, approximate

What Is Your Surface Area?

INTRODUCTION: The measure of a closed region of a plane is called its area. When you find how much paper it takes to cover a gift box, not counting the end flaps and folded parts, you are finding the surface area of the box. In this activity you are going to find the approximate surface area of your body.

PURPOSE:

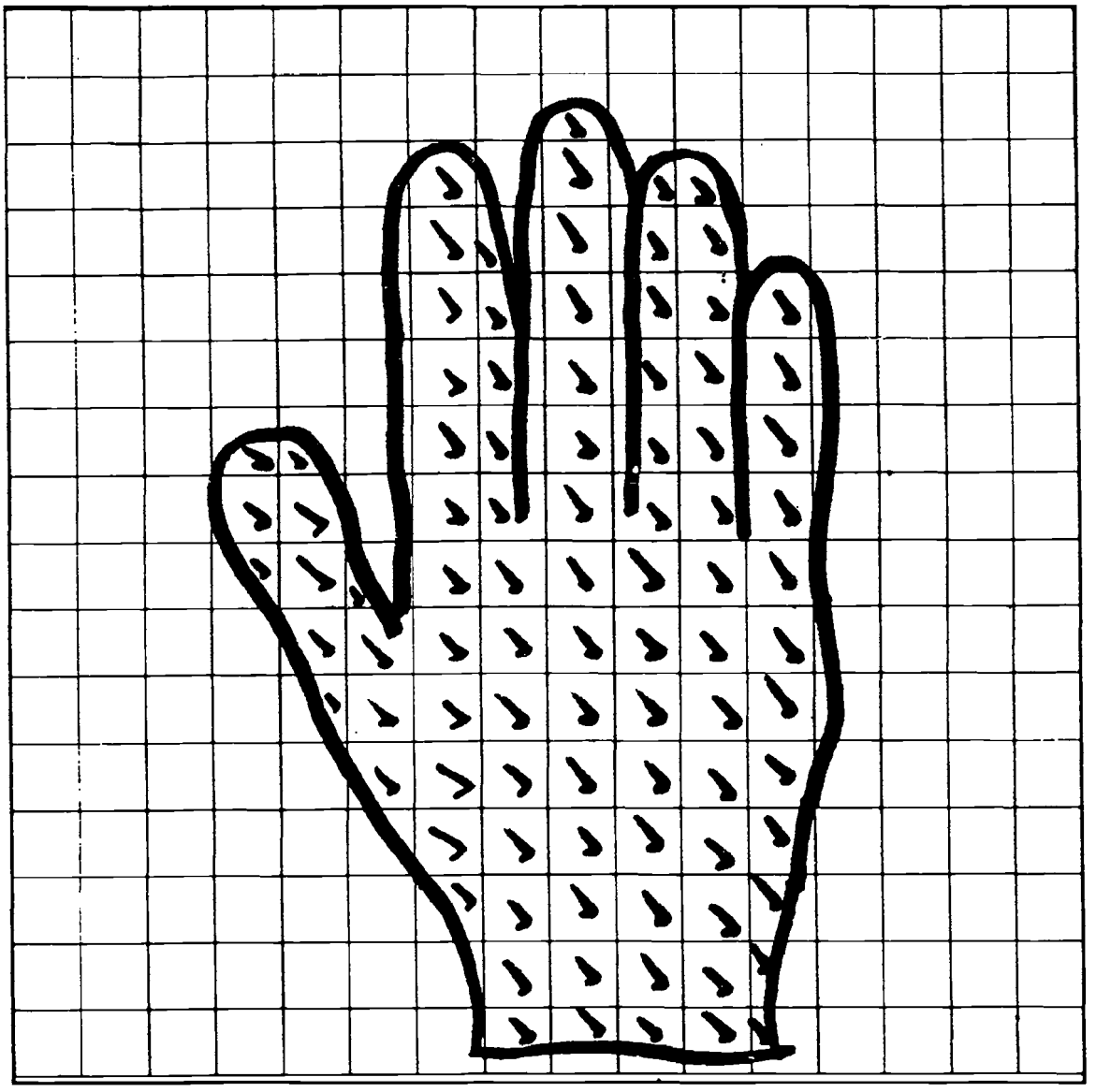
- ✓ What is the approximate surface area of your body?
- ✓ How can you find the approximate surface area of the body without measuring the entire body surface?

MATERIALS:

centimeter grid paper
pencil or crayon

PROCEDURES:

1. Place your hand on the centimeter grid paper.
2. Trace an outline of your hand with the pencil or crayon.
3. Put a check in each square within the outline, even if only part of the square is included.
4. Multiply the number of checks by 100. This number is the approximate surface area of the body.
   For example, the surface area of the hand shown in illustration 34–1 on the next page, is about 92 square centimeters. **The surface area of one's body is about 100 times the surface area of the hand.** 100 x 92 = 9,200 square centimeters. The surface area of the person whose hand is shown is about 9,200 square centimeters.
5. What is the surface area of your hand? What is the surface area of your body?



34 - 1 *Outline your hand on grid paper.*

6. Repeat the activity using your other hand. Does each hand have about the same number of square centimeters?

OBSERVATIONS:

1. How many checks are included inside the outline of your hand? ***Answers vary.***

2. When you multiply the number of checks by 100, what is the approximate surface area of your body? ***Answers vary.***

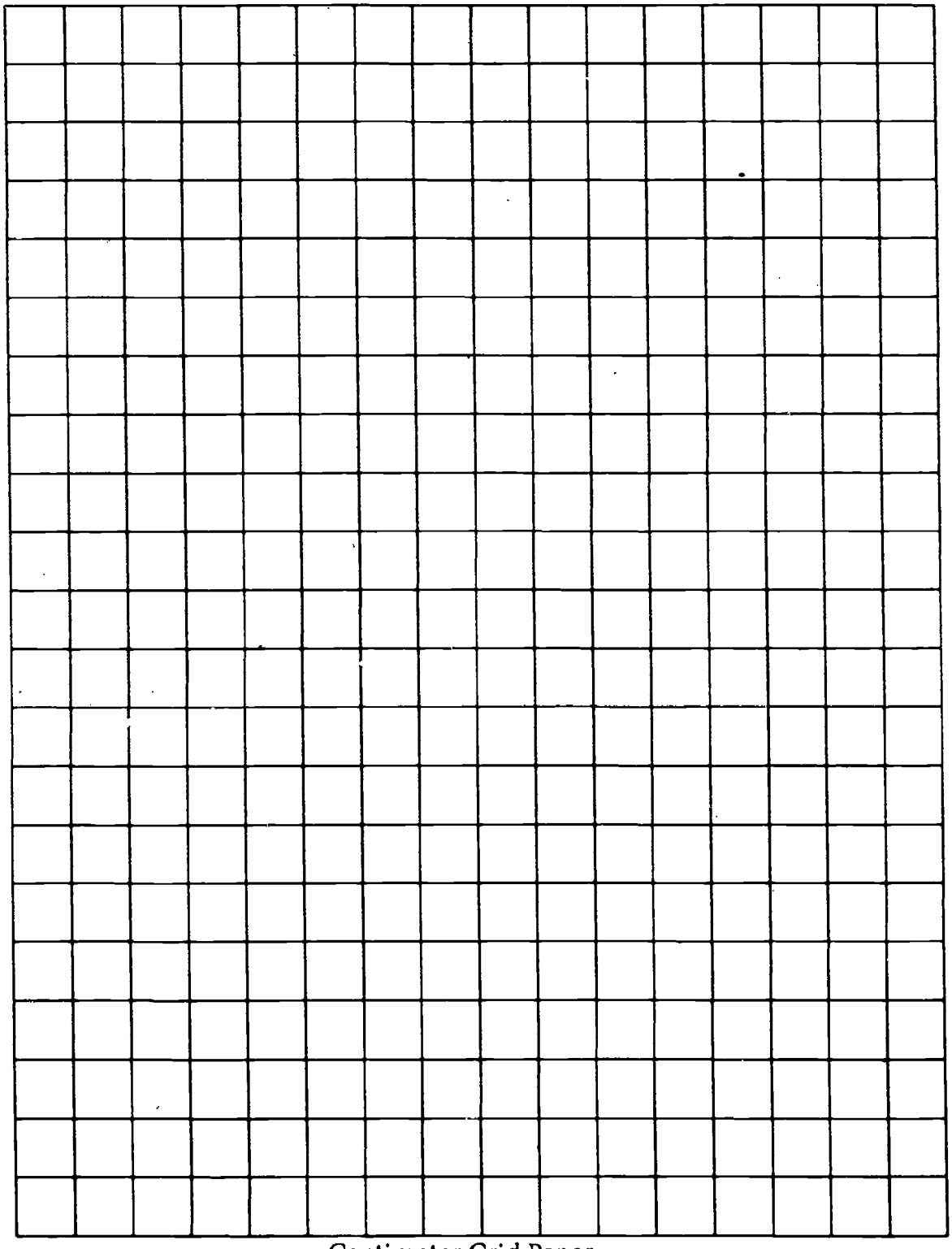
CONCLUSIONS:

1. Do you think that the way you found your surface area can be used to find the surface area of a baby or a large person? Why or why not?
   Yes. Answers vary.
2. Would the same procedure work to find the surface area covered by hair on a dog or cat? ***Answers vary; probably yes.***

SUGGESTIONS FOR FURTHER STUDY:

- Try this activity again using the hands of several adults. Find an average surface area of an adult.
- Work with a friend. Use a roll of bathroom tissue. Have your friend wrap your body from head to toe with the bathroom tissue. (Do not tear the sheets apart.) Then have your partner gently unwrap the tissue. Count the number of sheets of tissue that have covered your body. What is your surface area in tissue squares? Repeat the activity by wrapping your partner. Do you think this is an accurate way to find the surface area of your body? Why or why not?

Response Sheet
What Is Your Surface Area?



Centimeter Grid Paper

Teacher's Guide
Macaroni Math

GOAL: To have students explore large numbers with real objects and to refine their skills of estimation of numbers.

STUDENT OBJECTIVES:

- ✓ To investigate estimation of large numbers of objects.
- ✓ To use various techniques to aid in making accurate estimates.

GUIDE TO THE INVESTIGATION: Discuss with students the need to sometimes make a guess about numbers. For example, we might guess it will take about 30 minutes to go from one place to another. Point out that our estimates are not just wild guesses, but are based on something we know or something we figure out.

Students need a large jar, dried macaroni or shells, a cup, a tablespoon, scales or a balance, and centimeter grid paper (included) for this exploration. Students can work individually or in pairs with the assistance of an adult.

Have students follow these directions:

1. Fill a jar with dried pieces of macaroni. Do not count the macaroni (or shells) as you fill the jar.
2. Estimate the number of pieces of macaroni or shells there are in the jar. Write your estimate on the Response Sheet.
3. Next, fill a tablespoon with the macaroni or shells. Count the number of shells in the tablespoon. Make a new estimate of the number of spoonfuls there are in the jar. Then estimate and write the number of pieces of macaroni or shells in the jar on the Response Sheet.
4. Fill a cup with macaroni or shells. Count the number of pieces in the cup. Then make a new estimate of the number of pieces of macaroni or shells in the large jar and record it on the Response Sheet.
5. Lay out the pieces of macaroni or shells on the centimeter grid paper on your Response Sheet. Lay them out evenly, with no sides touching. How many pieces or shells are there on the Response Sheet?
6. Next, spill the jar of macaroni on a large sheet of centimeter grid paper. Use the centimeter squares to help you make another estimate of how many pieces of macaroni or shells are in one jar. Record your estimate on the Response Sheet.

7. Count the number of pieces of macaroni on the grid paper. Discuss the Observations and Conclusions.

VOCABULARY: estimate

Macaroni Math

INTRODUCTION: Have you ever participated in a contest where you try to guess the number of beans or candies in a jar in order to win a prize? Have you ever wondered how the person who won made the closest guess? In this activity you will use several techniques to help you make a good estimate of the number of objects in a jar.

PURPOSE:

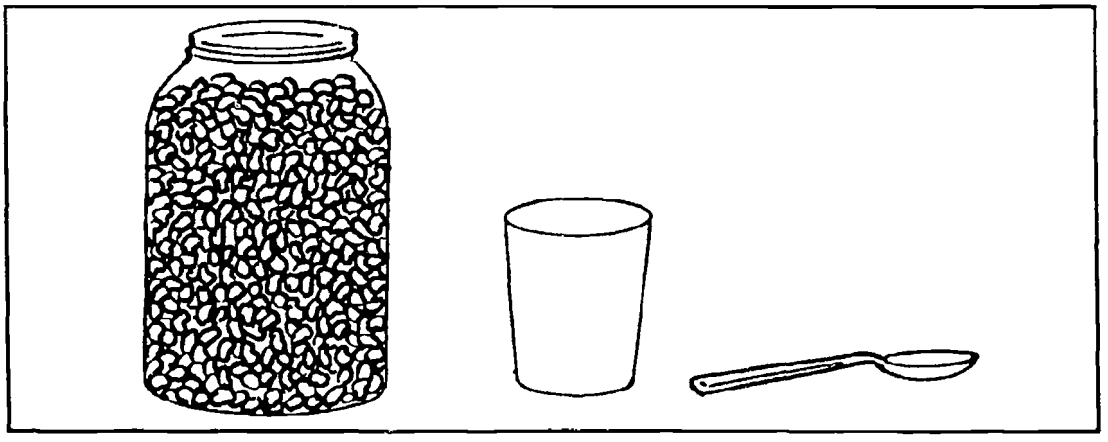
- ✓ What is estimation?
- ✓ What strategies can be used to help in making good estimates?

MATERIALS:

large jar
dried macaroni or shells
cup
spoon
centimeter grid paper (included)
scales or balance

PROCEDURES:

1. Fill the large jar with macaroni or shells. Do not count the macaroni or shells as you put them in the jar.
2. Estimate (make a guess) the number of pieces of macaroni or shells there are in the jar. Write your estimate on the Response Sheet.



35 - 1

3. Next, fill a tablespoon with macaroni or shells. Count the number of pieces of macaroni or shells in the tablespoon. Compare the tablespoon with the jar. About how many tablespoons will be needed to fill the jar? Now estimate the number of macaroni or shells there are in the jar. Write your estimate on the Response Sheet.

4. Then fill a cup with pieces of macaroni or shells. Count the number of pieces or shells in the cup. How many cups do you think it will take to fill the jar? Make a new estimate of the number of pieces there are in the jar. Write your estimate on the Response Sheet.

5. Lay out pieces of macaroni on the centimeter grid paper on the Response Sheet. Lay them out evenly so that no sides are touching. Count the pieces. Then estimate and record the number of pieces you think there are in the jar. Write your estimate on the Response Sheet.

6. Finally, spill the jar of macaroni on a large sheet of centimeter grid paper. Use the centimeter squares to make another estimate of how many pieces of macaroni or shells are in the jar. Record your estimate on the Response Sheet.

7. Count the number of pieces of macaroni on the graph paper.

OBSERVATIONS:

1. How many pieces of macaroni were in the tablespoon? ***Answers vary.***

2. How many pieces of macaroni were in the cup? ***Answers vary.***

3. How many pieces of macaroni were on the centimeter squares on the Response Sheet? ***Answers vary.***

4. How many pieces of macaroni were in the large jar? ***Answers vary.***

CONCLUSIONS:

1. Which of your estimates were closest to the actual number of pieces of macaroni in the jar? ***Answers vary. Possible answer may be the macaroni on the centimeter grid paper.***
2. Why was this estimate closest? ***Answers vary.***
3. What strategies would you suggest someone use in order to make an accurate estimate? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

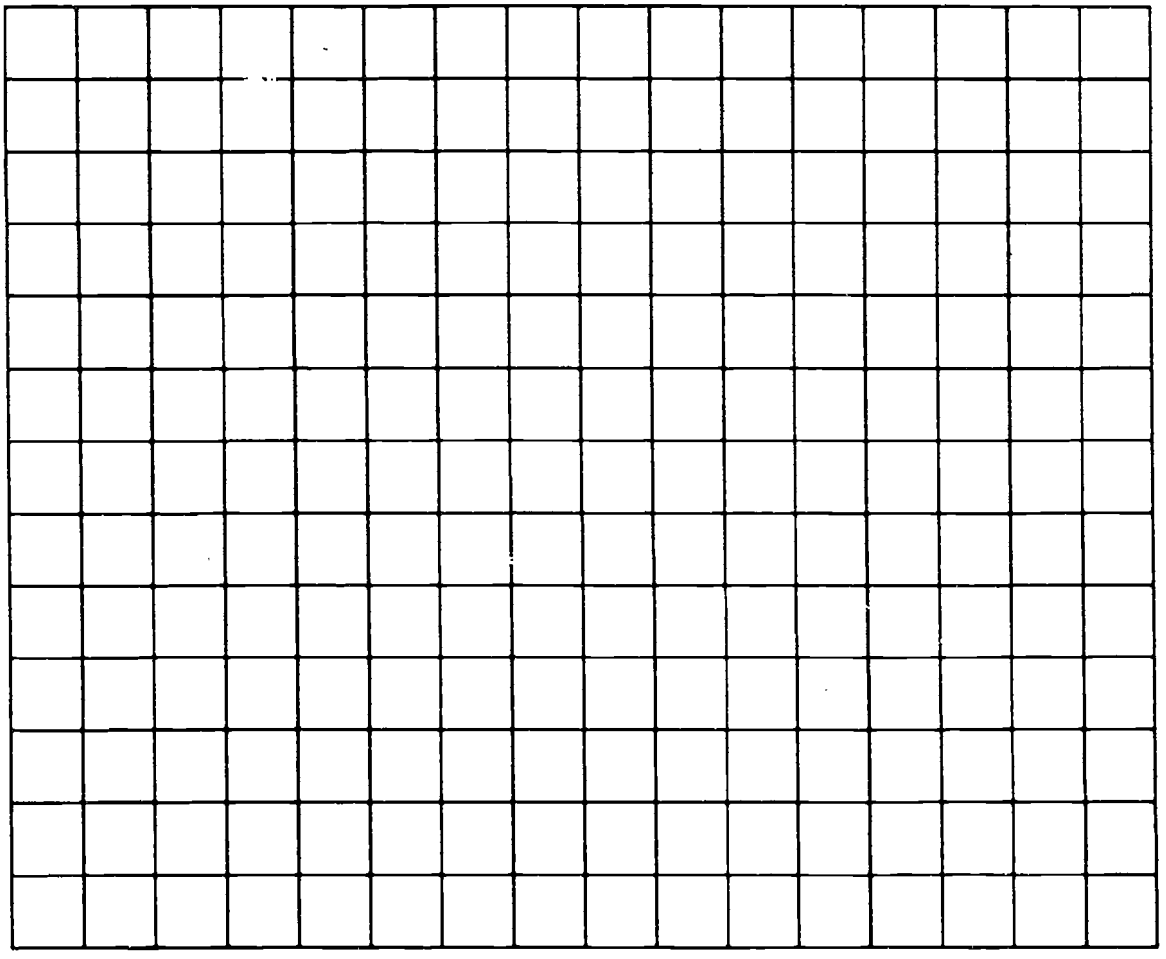
- Use index cards to make a set of "estimate cards". Use a marker to make many dots on several index cards. Put different numbers of dots on each card. Exchange your cards with a partner. Each of you should estimate the number of dots on the card. Then count the dots to see if you were close to the actual number. What strategy did you use to make your estimate?
- Estimate the number of cartons of milk that are consumed in your school in a day and in a week. What are some things that you would ask or some strategies you would use to make an estimate of the cartons of milk consumed in a day or in a week? ***Answers vary.***

Response Sheet
Macaroni Math

How many in the jar?

First Estimate	***Answers vary.***
Estimate using a tablespoon. The tablespoon held ___ pieces.	
Estimate using a cup. The cup held ___ pieces.	
Estimate using macaroni spilled on grid paper. Number on graph paper on this sheet ___.	

Centimeter Grid Paper



REASONING

Teacher's Guide
Exploring Great Heights

GOAL: To have students explore using a height finder to find the height of very tall objects.

STUDENT OBJECTIVES:

- ✓ To make a height finder.
- ✓ To use the height finder to find the height of very tall objects.

GUIDE TO THE INVESTIGATION: Discuss that sometimes it is nearly impossible to directly measure the height of a tall object. Instead one must use indirect measures. Discuss direct and indirect measures.

Students need a 6 inch square of cardboard, a plastic drinking straw, glue, a straight pin, yarn or heavy thread and a nut, a washer, or a ball of clay for a weight, and a measuring tape. Students should each make a height finder, then work in pairs to use the height finders. Students need guidance and assistance from an adult to complete the construction of the height finder.

Have students follow these directions:

1. Cut the cardboard square along a diagonal line as shown in illustration 36-1.
2. Glue the two triangles together one on top of the other. Then glue the straw to the long side of the triangles.
3. Tie one end of thread or yarn around a straight pin.
4. Push the pin into the top corner of the triangle.
5. Tie the ball of clay, the washer, or the nut onto the other end of the string. (This weight should hang below the bottom of the triangle.)
6. Work with a partner and use the height finder to find the height of a wall on your school building.
7. Stand back from the wall so you can see its top.
8. Hold up the triangle and look through the straw. Move backward or forward until you can see the top of the wall through the straw. Find a position where you can see the top of the wall and the string hangs straight down the front edge of the triangle.

9. Have your partner use a measuring tape to measure the distance you are standing from the wall. Then have your partner measure the distance from your eyes to the ground. Add the two measurements. That total gives you the height of the wall.

10. Now help your partner do the same procedure. Compare your measurements.

Discuss the Observations and Conclusions.

VOCABULARY: ratios, diagonal, height, distance, direct measure, indirect measure

Exploring Great Heights

INTRODUCTION: Sometimes objects such as a tree or a building are too high to measure directly. In these cases we can make an indirect measure. In this activity you will make a height finder to help you find the height of tall objects or the length of long objects.

PURPOSE:

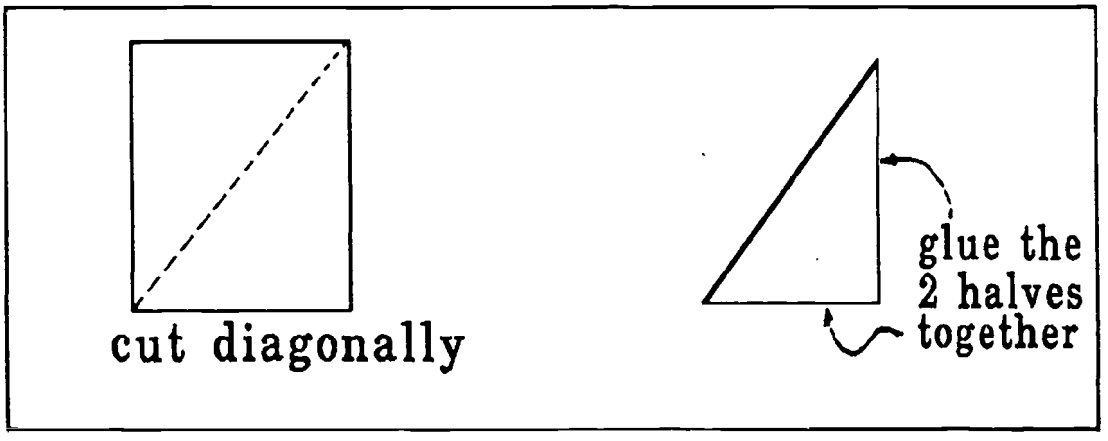
- ✓ How can you make a height finder?
- ✓ How can a height finder be used to find the height of tall objects?

MATERIALS:

6 inch square of cardboard
plastic drinking straw
white glue
straight pin
a nut, or a washer, or a ball of clay
measuring tape
heavy thread or yarn

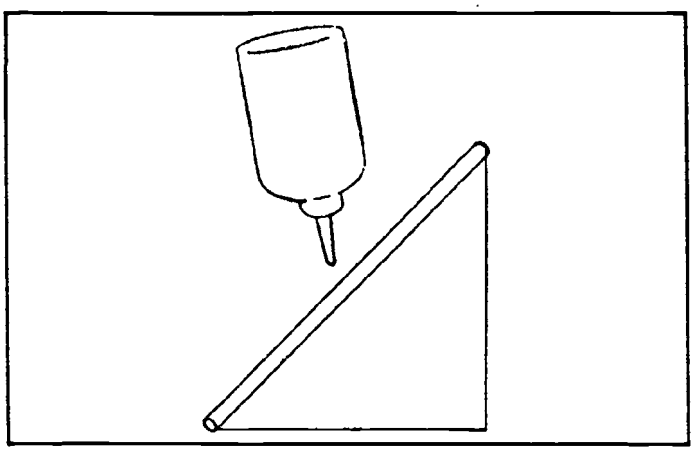
PROCEDURES:

1. Cut the cardboard square along a diagonal line from corner to corner. Then glue the two triangles together, one on top of the other, as shown in illustration 36-1.

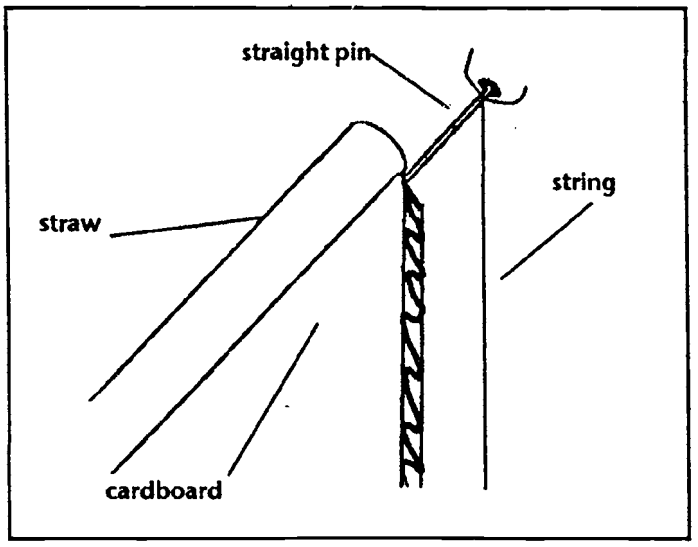


36 - 1

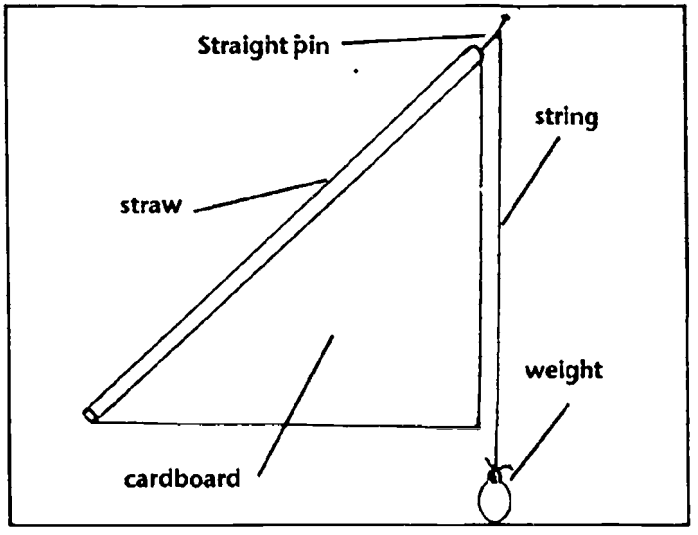
2. Glue the straw to the long side of the triangle. (See illustration 36–2.)
3. Tie one end of the thread around a straight pin.
4. Then push the pin into the top corner of the triangle. (See illustration 36–3.)
5. Tie the ball of clay, the nut, or the washer as a weight onto the other end of the string. (The weight should hang a little below the bottom of the triangle as in illustration 36–4.)
6. Work with a partner to use the height finder to find the height of a wall of your school.
7. Stand back from the wall so you can see the top of the wall.
8. Move backward or forward until you see the top of the wall through the straw. You must stand so that you can see the top of the wall and the string is hang-



36 - 2



36 - 3



36 - 4

ing straight down the front of the triangle. The string shows that the height finder is level.

9. Have your partner use a measuring tape to measure the distance you are standing from the wall. Then have your partner measure the distance from your eyes to the ground. Add the two measurements. That total gives you the height of the wall.
10. Now help your partner do the same procedure. Compare your measurements.

OBSERVATIONS:

1. What distance were you standing from the wall? ***Answers vary.***
2. What is your height from your eyes to the ground? ***Answers vary.***

CONCLUSIONS:

1. How does the height finder work? ***Answers vary. Possible answers relate to the Pythagorean theorem.***
2. How can the height finder be used to find the height of tall objects? ***Answers vary.***
3. Why did you measure from your eyes down to get your height? ***To complete the triangle.***

SUGGESTIONS FOR FURTHER STUDY:

- Work with a partner. Each of you measure and cut a strip of adding machine tape that is as long as you are tall. Write your names on your tapes. Once everyone in the class has cut paper tape equal to their height, tape the strips to the wall of your classroom. Who is the tallest? The shortest? Are some students the same height? How can you find out? Write several sentences that describe the heights of the students in your class.
- Use the height finder you made to figure out the height of a wall in your bedroom, the height of the basketball goal in the gym, and the height of the flag pole at your school.

Teacher's Guide
Same Volume - Same Capacity?

GOAL: To have students investigate the capacity and volume of various size three-dimensional containers.

STUDENT OBJECTIVES:

- ✓ To make cylindrical containers of varying sizes.
- ✓ To compare the capacity and volume of different containers made from the same size material.

GUIDE TO THE INVESTIGATION: Show a short "fat" glass and a tall "skinny" glass, each filled with water containing food coloring (red or blue). Have students discuss which they think holds more.

Students need construction paper (three 9 x 12 inch sheets), cardboard, tape, a measuring cup, and 2 cups of dried beans or rice for this exploration.

This activity may be carried out by pairs or small groups of 3 or 4 students with the guidance of an adult.

To construct and fill the containers, students should work on a flat, smooth surface such as a table top or a tiled floor.

Have students follow the directions in the Procedures section.

1. Cut the construction paper in half.
2. Make two tubes from the pieces of paper - one long and thin and the other short and fat. Tape the edges of the tubes. Cut a circle of cardboard to cover one end of each tube. Tape securely with two long pieces of tape in an X over the bottom.
3. Hold one container upright. Have your partner fill the container with beans or rice.
4. Then fill the other container (tube) with the beans or rice from the first container (tube). What do you discover?
5. Repeat the procedure using two full sized (9 x 12) sheets of construction paper. Did you get the same results?

After students complete this investigation, discuss the Observation and Conclusion questions.

VOCABULARY: volume, cylinder, capacity

Same Volume - Same Capacity?

INTRODUCTION: To compare the volume of hollow three-dimensional containers you can fill each with the same kind of material. In this activity you will make cylindrical containers of various sizes, fill them with rice or beans, and then compare the volumes of the containers.

PURPOSE:

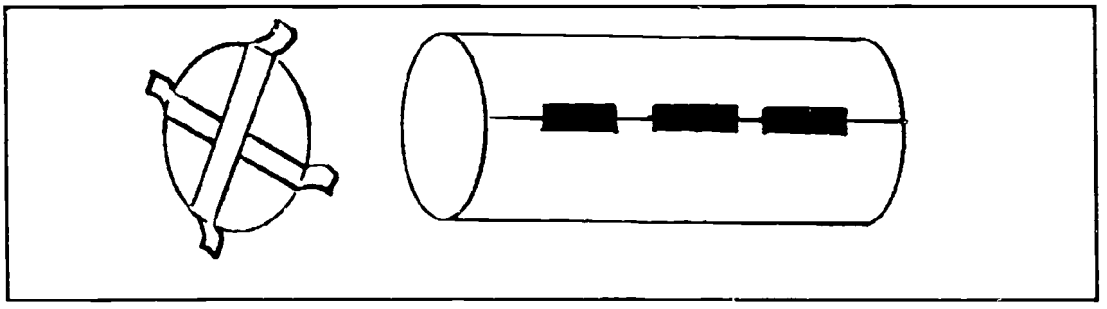
- ✓ How can various sized cylindrical containers be made from construction paper and tape?
- ✓ What can you do to compare the volumes of containers?

MATERIALS:

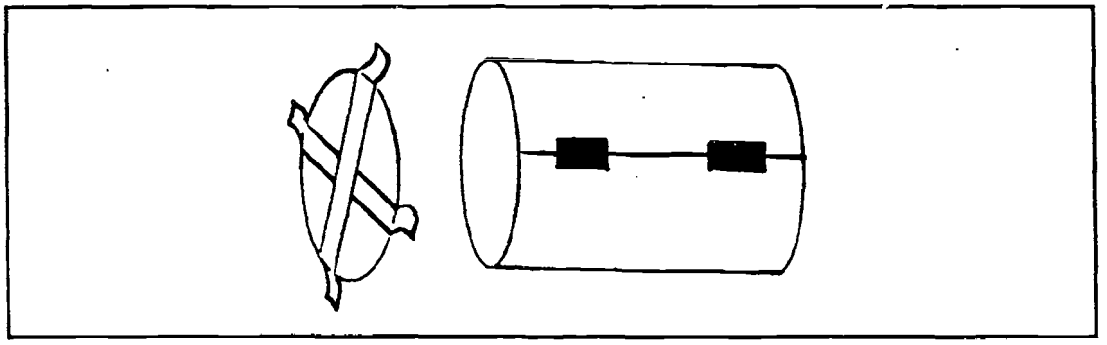
9 inch x 12 inch construction paper (three or more sheets)
tape
2 cups of dried beans or rice
measuring cup

PROCEDURES:

1. Work with a partner. Cut one 9" x 12" sheet of construction paper in half.
2. Make a round tube (a cylinder) by rolling one piece of construction paper the long way. Overlap the edges approximately $\frac{1}{4}$ inch and tape as shown in illustration 37-1. Cut a circle of cardboard to cover one end of the tube. Tape securely with two long pieces of tape in an X over the bottom.



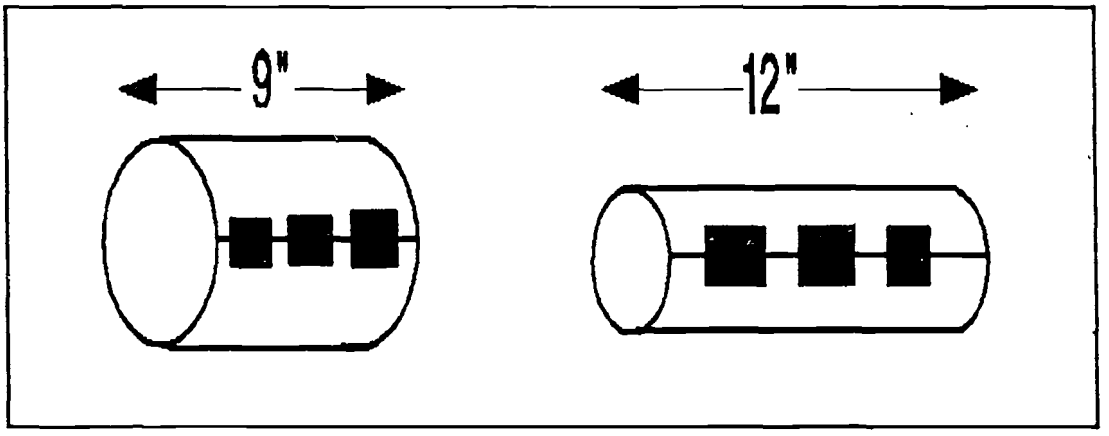
37 - 1



37 - 2

3. Roll the other half of the sheet of construction paper the "short" way to make a shorter, fatter cylinder. Overlap the edges approximately $\frac{1}{4}$ inch and tape as shown in illustration 37-2. Cut and tape a cardboard bottom for one end.

4. Stand both of the cylinders up on a table or other smooth surface. Carefully hold one cylinder upright. Have your partner fill the container with beans or rice.



37 - 3

5. Then carefully pour the beans or rice into the other cylindrical container. Do the containers hold the same amount?

6. Roll a 9" by 12" sheet of construction paper to make a long cylinder. Roll another 9" by 12" sheet of construction paper to make a fatter cylinder.

7. Repeat the procedure as you did with the half sheets of paper. Do these two containers hold the same amount of beans or rice?

OBSERVATIONS:

1. Do the thin cylinder and the fat cylinder made from the halves of the sheet of construction paper both hold the same amount of rice or beans? ***Yes.***

2. Do the thin and fat cylinders made from the whole sheet of construction paper both hold the same? ***Yes.***

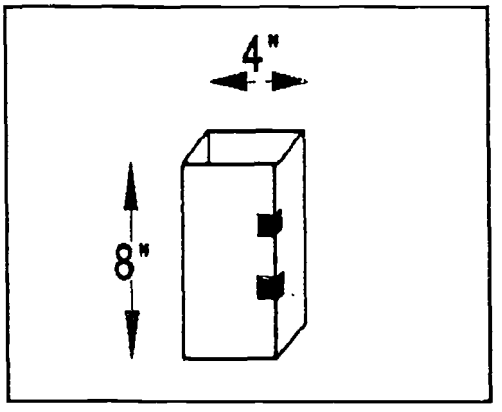
CONCLUSIONS:

1. Describe why the cylinders do or do not hold the same amount and formulate a generalization. ***Answers vary. They may look as though they hold different amounts, but they hold the same.***

2. Will the generalization you made for the paper cylinders be true for all pairs of cylindrical containers that are made from the same size materials? ***Yes.***

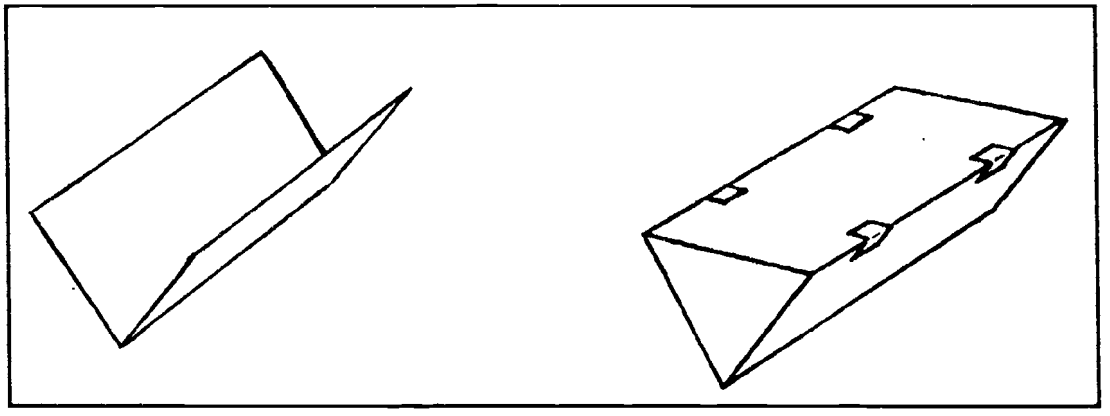
SUGGESTIONS FOR FURTHER STUDY:

- Repeat the activity using two 8-inch squares of paper. Fold them in half. Tape together to make a rectangular container as shown in illustration 37–4. Cut and tape a cardboard bottom for one end. Fill with beans or rice. Use a measuring cup to find how much the rectangular container will hold.



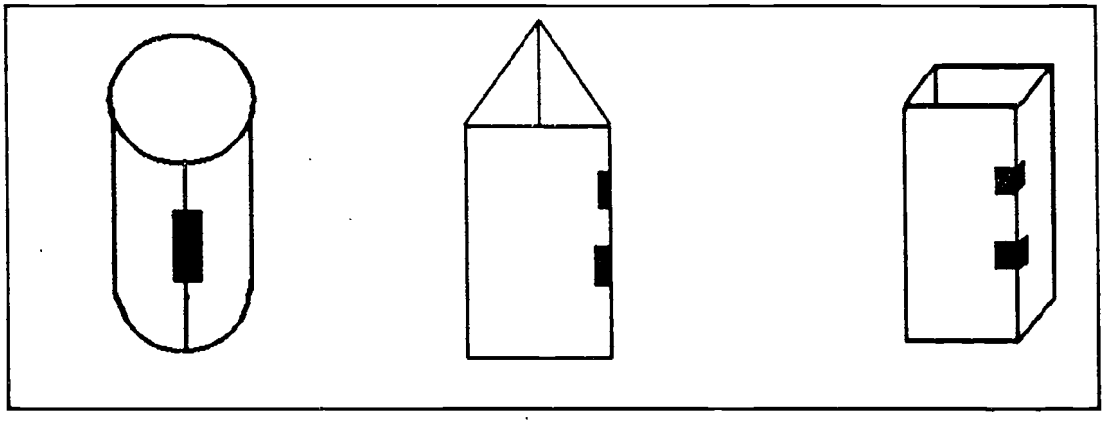
37 - 4

- Use two identical 8 inch squares. Fold one in half. Let it stand open in a "V". Tape the other 8 inch square over the top of the "V" as shown in illustration 37– 5. You will have a triangular container. Cut and tape a cardboard bottom for one end. Stand the trough on end and fill with rice or beans. Which holds more - the rectangular container or the triangular one?



37 - 5

- Make three rectangles the same size from stiff paper. Make a cylindrical container from one rectangle. Make a triangular container from one rectangle. Make a rectangular container from the third rectangle. Cut and tape cardboard bottoms for each container. Fill each with beans or rice. Compare the amount each container holds.



37 - 6

Teacher's Guide
Experimenting With A Thumbtack

GOAL: To have students explore making predictions by tossing a thumbtack to find whether it lands point up or point down (on its side).

STUDENT OBJECTIVES:

- ✓ To experiment by tossing a thumbtack.
- ✓ To make predictions about how a thumbtack will land.

GUIDE TO THE INVESTIGATION: Discuss the meaning of probability, for example, the chance that it will rain or snow. Explain to students that predictions are not just wild guesses but are educated guesses based on some previous findings.

Students need thumbtacks, a paper cup, pencil, and the Response Sheet for this exploration.

This activity can be investigated by pairs or small groups of students with a minimal amount of assistance from an adult.

Have students follow these directions:

1. Toss a thumbtack and let it fall on a table top.
2. Record on the Response Sheet how the thumbtack landed. Did it fall with the point up or did it fall on its side with the point down?
3. Repeat the toss 10 times. Predict the number of times the tack will land with the point up and the number of times it will land on its side in 40 more tosses.
4. Toss the tack 40 more times. Record on the Response Sheet how the tack lands.
5. Was your prediction correct? Discuss with a partner why or why not.
6. Repeat the thumbtack toss 50 more times. Did the thumbtack land with its point up or down as it did in the first 50 tosses?

When students complete the thumbtack toss, discuss the Observation and Conclusion questions.

VOCABULARY: probability, toss, predictions

Experimenting With A Thumbtack

INTRODUCTION: Sometimes you can make a prediction about what will happen based on what has happened in the past. You can do experiments and find patterns that may help you predict what is likely to happen. In this activity you will toss a thumbtack and make predictions about how it will land when it is tossed.

PURPOSE:

- ✓ How can the tossing of a thumbtack be used to make predictions?
- ✓ What are some uses of probability?

MATERIALS:

thumbtacks
paper cup
pencil

PROCEDURES:

1. Toss a thumbtack and let it fall on a table top.
2. Record on the Response Sheet how the thumbtack landed. Did it fall with the point up or did it fall on its side with the point down?
3. Repeat the toss 10 times. Predict the number of times the tack will land with the point up and the number of times it will land on its side if you toss the tack 40 times.
4. Toss the tack 40 more times. Record on the Response Sheet how the tack lands.
5. Was your prediction correct? Discuss why or why not.
6. Repeat the thumbtack toss 50 more times. Did the thumbtack land with its point up or down as it did the first 50 tosses?

OBSERVATIONS:

1. How many times out of 50 tosses did the thumbtack land with the point up? With the point down? ***Answers vary.***
2. Were you able to predict, after 10 tosses, the number of times the tack would land point up and the number of times it would land point down? Why or why not? ***Answers vary. Possible answer may indicate a prediction was made for equal landings on the tosses but the results were different.***

CONCLUSIONS:

1. Why is it difficult to predict how the thumbtack will land when it is tossed? ***Answers vary.***
2. What other object might you be able to toss and accurately predict whether it will land up or down or heads or tails? ***A penny; a two sided counter.***

SUGGESTIONS FOR FURTHER STUDY:

- Flip a coin 50 times and record the number of times it lands on heads and the number of times it lands on tails. How are the results of flipping the coin 50 times different from tossing the thumbtack 50 times? Why do you suppose this is?
- Work with 4 or 5 other students. Cut several old telephone directory pages into strips. Give each student in your group a strip containing telephone numbers. For each telephone number, add the last 4 digits. For example, the phone number 555-1284 would give 15 because 1 plus 2 plus 8 plus 4 = 15. Write the sum for each number. Each of you make a chart that shows the sums of the numbers.

SUMS	
1	
2	
3	
4	
5	

6	
7	
8	
9	
10	
11	

12	
13	
14	
15	
16	
17	

Which sum showed up the most? Compare the results with others in your group. Make a large chart showing the sums from each member of your group. What sum appears most? Do you think this will hold true for all telephone numbers? Why or why not? ***Answers vary.***

Response Sheet
Experimenting With A Thumbtack

TOSSES	point up	point down	TOSSES	point up	point down
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Teacher's Guide
Experimenting With Slant

GOAL: To have students identify patterns related to slant, speed, and time while investigating with cars on ramps.

STUDENT OBJECTIVES:

- ✓ To investigate the effect of different heights of ramps on the speed of a car.
- ✓ To identify patterns related to slant, speed, and time.

GUIDE TO THE INVESTIGATION: Discuss with students why an automobile driver must apply brakes when going down a hill. Discuss why a driver must accelerate on relatively flat surfaces. Teach students how to operate a stop watch.

Students need a toy car, a board about 3 feet long and 4 to 6 inches wide, a stopwatch, 6 books, cardboard, tape, grid paper (included), and pencil.

This investigation should be carried out by groups of 3 or 4 students under the guidance of an adult.

Have students follow these directions:

1. Make a ramp for the toy car by placing one end of the board on two books that have been stacked. Place the other end of the board on the table or floor.
2. Tape a square of cardboard upright at the end of the board to serve as a stop for the car.
3. Position the car at the top of the ramp.
4. Prepare the stop watch to time how long it takes the car to roll to a stop against the cardboard.
5. Let the car roll down the ramp.
6. Stop the stop watch when the car touches the cardboard stop.
7. Record the time on the chart on the Response Sheet.
8. Add another book to the two books to make a steeper ramp.
9. Repeat the procedure. Record the time on the Response Sheet.

10. Repeat the experiment with 4 books, then 5 books, and then 6 books. Record the results on the Response Sheet.

11. Next make a graph showing the results of your experiment.

Discuss the Observations and Conclusions.

VOCABULARY: number patterns, slant, stop watch, ramp

Experimenting With Slant

INTRODUCTION: Have you ever been to the mountains or ridden on a roller coaster? When does an automobile or roller coaster car go faster? In this investigation you will explore what happens to the speed of a car when it goes down ramps with different slants. You will also make a graph to show the results of your investigation.

PURPOSE:

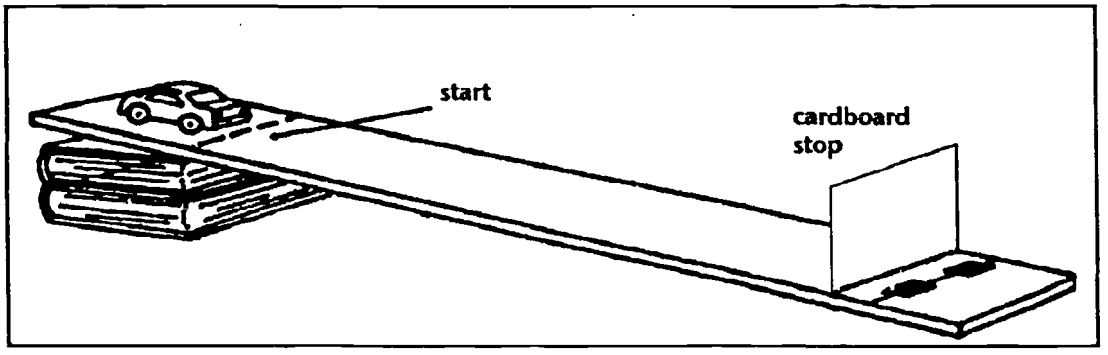
- ✓ What effect does the slant of a ramp have on the speed of a car?
- ✓ Can you identify a pattern based on the height of the ramp and the speed of the car?

MATERIALS:

toy car	cardboard
wooden board about 3 feet long	tape
stopwatch	pencil
6 books	grid paper (included)

PROCEDURES:

1. Make a ramp for the toy car. Place one end of the board on two books that have been stacked on top of each other. Place the other end of the board on the table or floor.
2. Tape a square cut from the cardboard at the end of the board to stop the car when it gets to the bottom. (See illustration 39-1.)



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3. Place the toy car at the top of the ramp.
4. Have a partner hold the stop watch and prepare to time the car when you let it go down the ramp. Let the car roll down the ramp.
5. Have your partner stop the watch when the car touches the cardboard stop. Record the time on the chart on the Response Sheet.
6. Add another book to the stack of books to make a steeper ramp.
7. Repeat the activity. Record the time on the Response Sheet.
8. Repeat the activity with 4 books, then with 5 books, and then with 6 books. Record the times on the Response Sheet.
9. Make a graph that shows the pattern you found in the time it took the car to go down the ramp as the slant became greater.

OBSERVATIONS:

1. Which car (the first, second, etc.) took the longest time to go down the ramp? ***Answers vary; it should have been the first one.***
2. Which car (the first, second, etc.) took the shortest time to go down the ramp? ***Answers vary; it should have been the last car.***

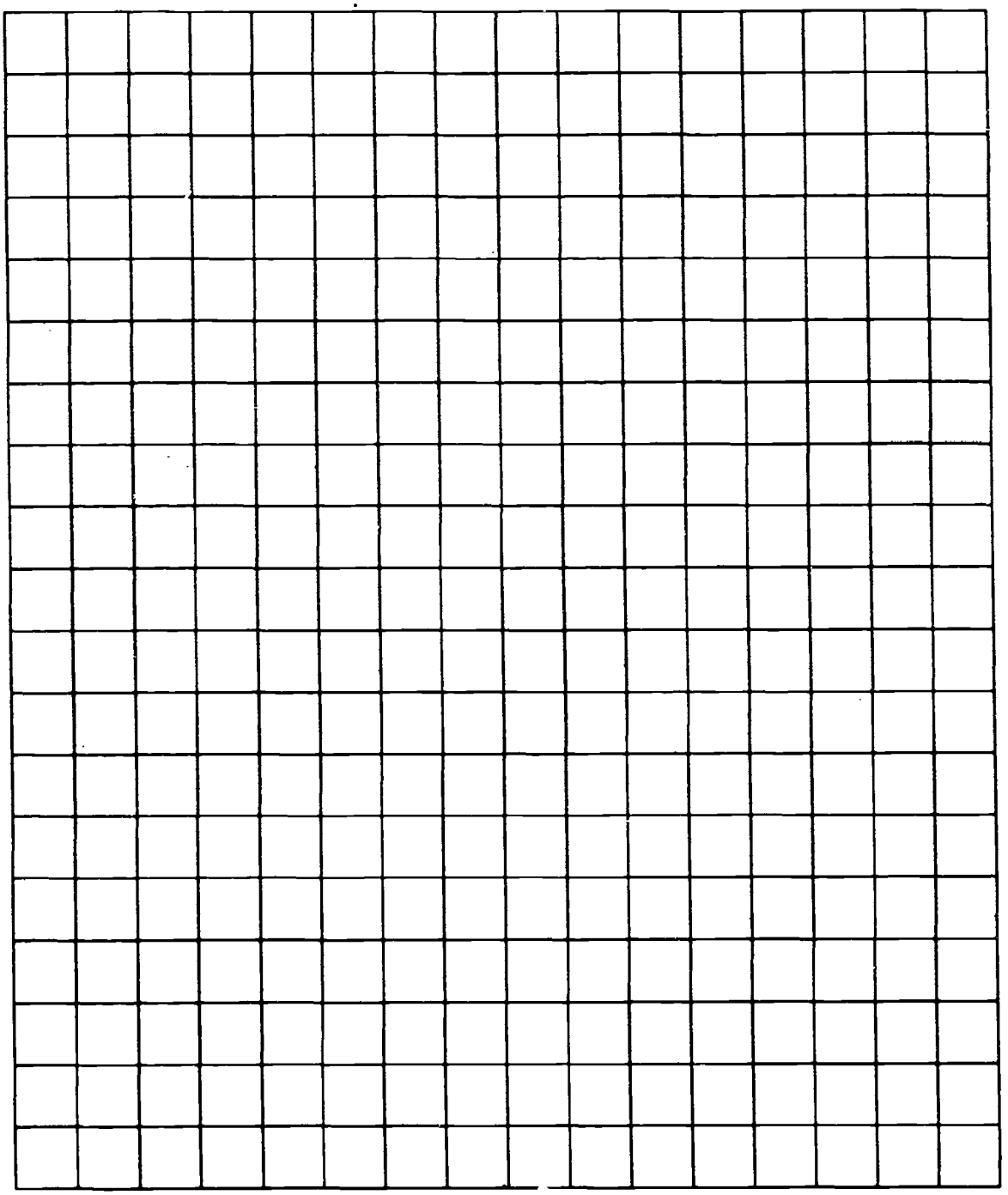
CONCLUSIONS:

1. What pattern do you see on the graph? ***Time decreased from the first car to the last car.***
2. What generalization can you make about the slant of the ramp and the time it takes a car to go down the ramp? ***A steeper ramp increases speed.***

SUGGESTIONS FOR FURTHER STUDY:

- Try the same experiment using two toy cars about the same size. Do the two cars take the same time to go down each ramp with the same slant? Why? Prepare a graph that shows the time of the two cars on each ramp. Discuss the results with a partner.
- Repeat a similar experiment using a large toy car and a small toy car. Record the results. Write a statement that you believe

explains why one of the cars takes less time to go down the ramp than the other car does.



Centimeter Grid Paper

Response Sheet
Experimenting With Slant

Number of Books	Time it took for car to reach the bottom of the ramp
2	*Times vary.*
3	
4	
5	
6	

Pattern I found in the amount of slant and the time it took the car to get to the bottom of the ramp:

Answers vary. Possible answer may note that the steeper the ramp, the faster the speed of the cars.

Teacher's Guide
Creative Cube Work

GOAL: To have students explore three-dimensional shapes by making cubes and experimenting with shapes in space.

STUDENT OBJECTIVES:

- ✓ To build larger cubes from smaller cubes.
- ✓ To determine the number of faces on the smaller cubes used to make larger cubes.
- ✓ To explore shapes in space.

GUIDE TO THE INVESTIGATION: Show a large solid cube to students. Show them another cube that is marked showing smaller cubes, such as the decimeter cube showing 1000 cm. Discuss the faces on the cubes.

Students need sugar cubes, glue or paste, paint, and paint brushes for this activity. This activity may be carried out by pairs of students under the guidance of the teacher or other adult.

Direct students to follow the directions in the Procedures section.

1. Use sugar cubes and glue to build a cube with dimensions of 3 cubes by 3 cubes by 3 cubes. Let the large cube dry. Make a drawing of the cube on the Response Sheet.
2. Paint the outside of the large cube. Paint all faces including the bottom.
3. When the paint is dry take the cube apart. On the chart on the Response Sheet, record the number of faces that are painted.
4. Next make a cube that is 4 cubes by 4 cubes by 4 cubes. Glue the cubes together. Paint all faces including the bottom. How many faces are painted? When the cube is dry, take it apart and find the number of small cubes that have 0, 1, 2, or 3 faces painted. Record the number on the chart.
5. Make a cube that measures 5 cubes by 5 cubes by 5 cubes. Repeat the procedures as you did for the 3 by 3 by 3 and 4 by 4 by 4 cubes. On the Response Sheet, record the number of cubes with painted faces.
6. Build a cube in which all the small cubes have three faces painted. On the Response Sheet, draw a picture of the larger cube. Take the cube apart. How many small cubes did it take to build this cube?

Discuss the Observations and Conclusions.

VOCABULARY: three-dimensional, cubes, space figures, faces

Creative Cube Work

INTRODUCTION: One way to learn about three-dimensional shapes is by experimenting with them. A cube has six square faces. It takes 27 cubic units to build a cube that has the dimensions of 3 by 3 by 3. In this activity you will build large cubes using sugar cubes and determine the number of faces on cubes.

PURPOSE:

- ✓ What is the least number of sugar cubes needed to build a cube larger than 1 by 1?
- ✓ How can the number of faces of a larger cube made from smaller cubes be determined?

MATERIALS:

sugar cubes
paint
paint brush
glue or paste

PROCEDURES:

1. Use sugar cubes and glue to build a cube with the dimensions of 3 cubes by 3 cubes by 3 cubes. Make a drawing of the cube on the Response Sheet. Let the cube dry.
2. Paint the outside of the large cube. Paint all faces including the bottom.
3. When the paint is dry, take the cube apart. On the chart on the Response Sheet, record the number of faces that are painted.
4. Next make a cube that is 4 cubes by 4 cubes by 4 cubes. Glue the cubes together. Paint the outside of the large cube. Paint all faces including the bottoms. When the cube is dry, take it apart and find the number of small cubes that have 0, 1, 2, or 3 faces painted. Record the number on the chart.

5. Make a cube that measures 5 cubes by 5 cubes by 5 cubes. Repeat the procedures as you did for the 3 by 3 by 3 and 4 by 4 by 4 cubes. On the Response Sheet, record the number of cubes with painted faces.

6. Build a cube in which all the small cubes have three faces painted. On the Response Sheet, draw a picture of the larger cube. Take the cube apart. How many small cubes did it take to build this cube?

OBSERVATIONS:

1. How many cubes were used to make a 3 by 3 by 3 cube? ***27***

2. How many small faces are visible in a 3 by 3 by 3 cube. ***54***

CONCLUSIONS:

1. What is the smallest number of small cubes that can be used to make a cube larger than 1 cube by 1 cube? How do you know? ***8; answers vary.***

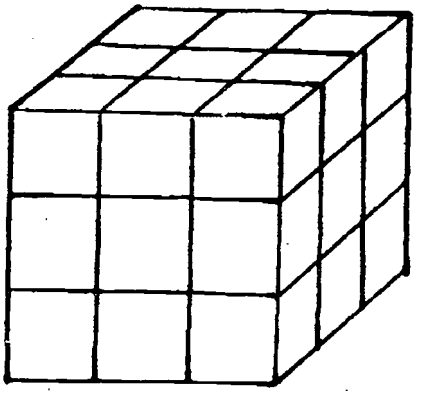
2. Can you find a way to determine the number of cubes not visible in a cube that measures 5 cubes by 5 cubes by 5 cubes? ***Answers vary.***

SUGGESTIONS FOR FURTHER STUDY:

- Take a walk around the playground or your neighborhood. Look for three-dimensional figures. Sketch the shapes you observe. When you return to class, work with a partner to examine your sketches. Decide which figures can be broken down into smaller figures as the cubes were in this activity. Prepare a poster that displays your findings.
- Work with a group of 3 or 4 other students. Use blocks, unifix cubes, and other pattern blocks to construct a village or city. Draw the streets or roads on large sheets of butcher paper or newsprint. Include as many three-dimensional shapes as possible in your city.

Response Sheet
Creative Cube Work

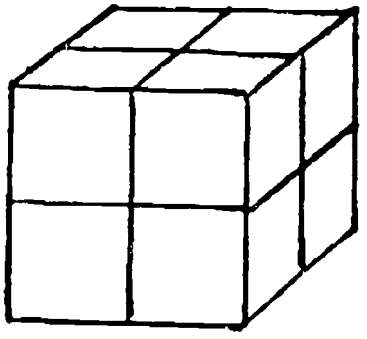
1. Make a drawing of a 3 by 3 by 3 cube made using sugar cubes.



2.

	Faces Painted			
Cube	0	1	2	3
3 x 3 x 3	*1*	*6*	*12*	*8*
4 x 4 x 4	*16*	*24*	*16*	*8*
5 x 5 x 5	*27*	*54*	*36*	*8*

3. Make a drawing of the cube in which all the small cubes have three faces painted. What are the dimensions of the cube?



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